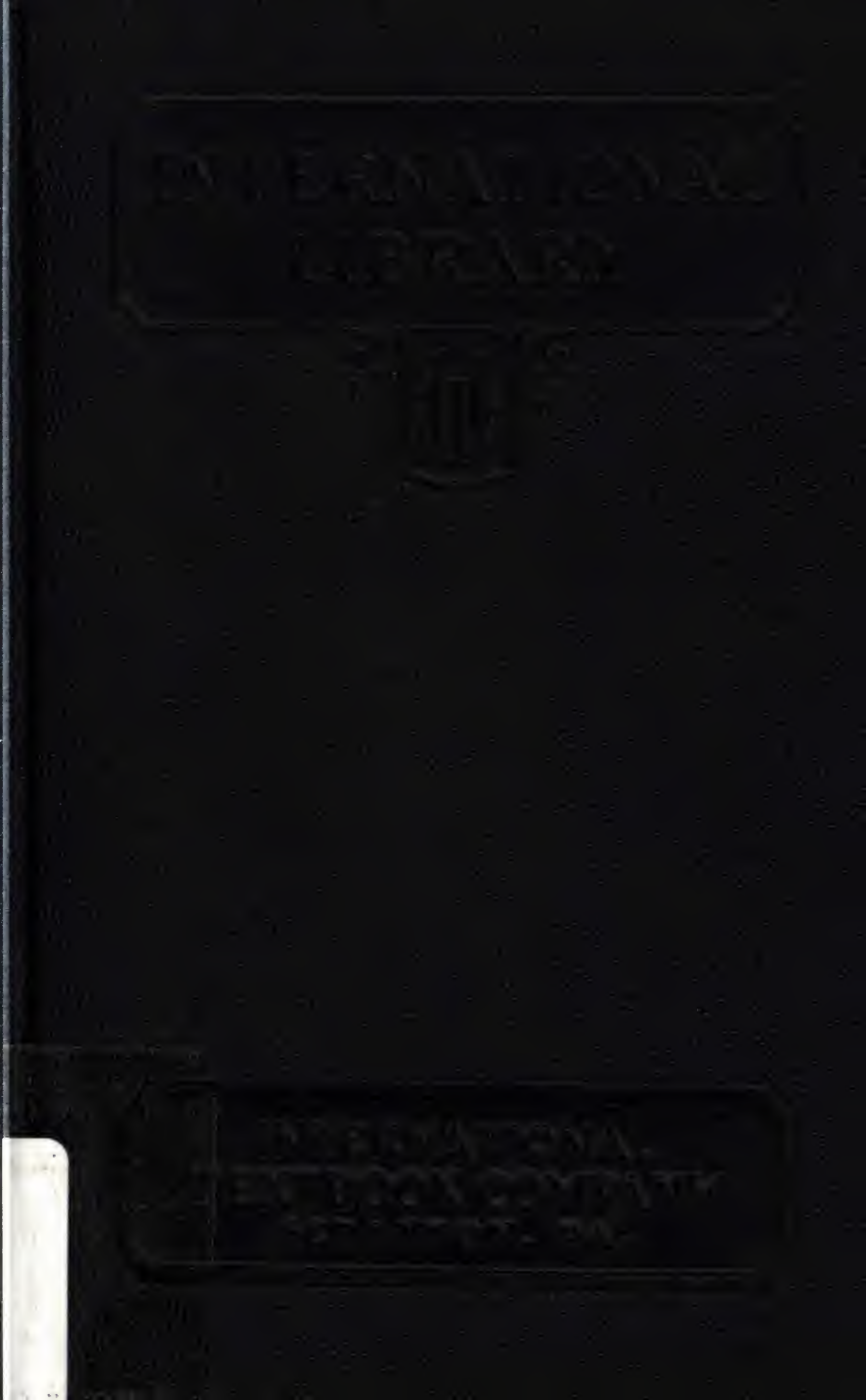

Floor and Wall Coverings

By

VICTOR DARWIN ABEL, A. I. A.

ARCHITECT

FLOOR AND WALL
COVERINGS

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FLOOR AND WALL COVERINGS

Serial 5375 Edition 1

FLOOR COVERINGS

INTRODUCTION

1. Scope of Subject.—Floor and wall coverings, as considered in this lesson, are the finished materials that form the exposed surfaces of floors and walls. In order to give an understanding of their uses and the purposes to which each material is especially adapted, the characteristics of the various materials will be described. Not only the better known materials, but many new kinds recently developed and now coming into more common use, will be discussed.

2. In modern methods of construction employed in fireproof buildings, the structural walls and floors are not built until the skeleton framework has been erected. The materials used to form the decorative and wearing surfaces for both floors and walls are generally applied after the structural portions have been completed. The floor and wall construction will be shown, therefore, only to the extent necessary to illustrate proper methods of installing and supporting the finished coverings.

3. Analysis and Fitness of Materials.—Many of the materials described herein have been used since the earliest stages of civilization. Brick, stone, wood, tile, and plaster have been used and tested under actual conditions, for many centuries. They have been tested also by laboratory experiment, until there is no question as to their fitness for certain definite purposes.

4. The exacting requirements under which modern building construction is carried on, make it necessary to have definite data regarding the qualities of each material. These data

include the results of chemical and physical tests; precise information as to hardness or resistance to wear; the absorption of water, resistance to the transmission of heat and cold, the absorption of sound, acid resistance, and other qualities. In many cases data of this kind can be obtained at the National Bureau of Standards in the Department of Commerce, which is a testing organization maintained by the United States Government at Washington. It may be necessary, for special or newly developed materials, to secure such data from the manufacturer. The composition and qualities of natural materials, such as stone and wood, are generally definitely understood. Their successful use depends on proper production, fabrication, and installation.

Fabricated materials, such as brick, tile, linoleum, glass, etc., are manufactured from natural materials and assembled by various methods into the finished articles. Standard specifications have been adopted for their manufacture. These specifications are the result of experiments by manufacturers and of use of the materials in actual construction. They are also developed by Departments or Bureaus of the National Government.

5. Installation of Materials.—Industrial associations have developed methods of production as well as definite recommendations for installing various materials. These installation methods are described in this lesson, and should be followed in actual construction whenever possible.

Many of the newly developed kinds of materials have been in use for only a comparatively short time. They are the result of experiment and research by individual producers. Definite information as to their characteristics and methods of installation should be secured for the application of each material, direct from the producer, and should be followed in order to use each material successfully.

SELECTION OF FLOOR COVERINGS

6. Chief Considerations.—In the selection of floor coverings, there are three major considerations, all of which influence the final choice. These are wear, design, and cost.

7. Wear.—Wear includes many factors, such as *hardness, or resistance to abrasion,* which is necessary where there is heavy traffic; *softness* to provide for the comfort of men who are on their feet all day long, and where *sound absorption* is desirable; *acid resistance,* as in laboratories; *water resistance,* as in washrooms; *non-slip surfaces,* as in stairs, or where there are wet or greasy floors.

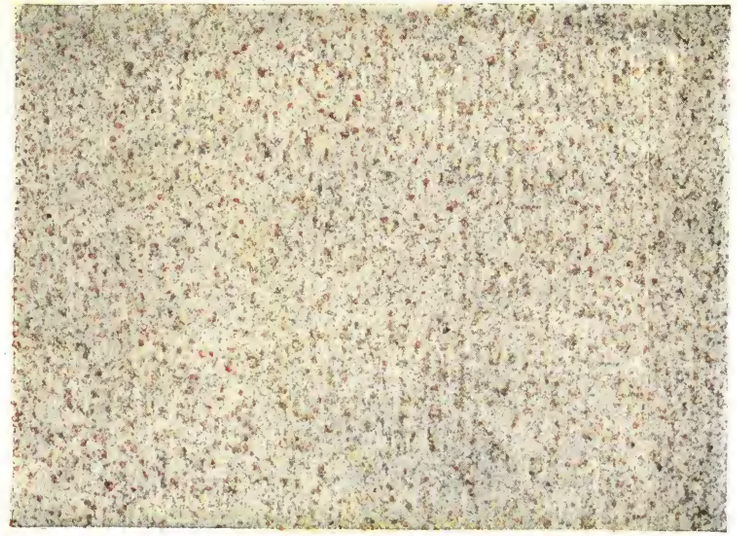
Often, two or more of these factors must be considered together, as in a printing plant, where there is abrasion due to heavy trucking and where there is much walking about, or in the corridor of a school building, where it is necessary to resist the wear due to changing classes and to avoid noises that might disturb classes that are in session.

8. Design.—Design in floor coverings is primarily the selection, arrangement, and manufacture of materials to suit the type of architecture employed or the tastes of the purchaser. Many materials occur in nature, and their natural sizes, forms, colors, and textures cannot be varied except within fixed limits.

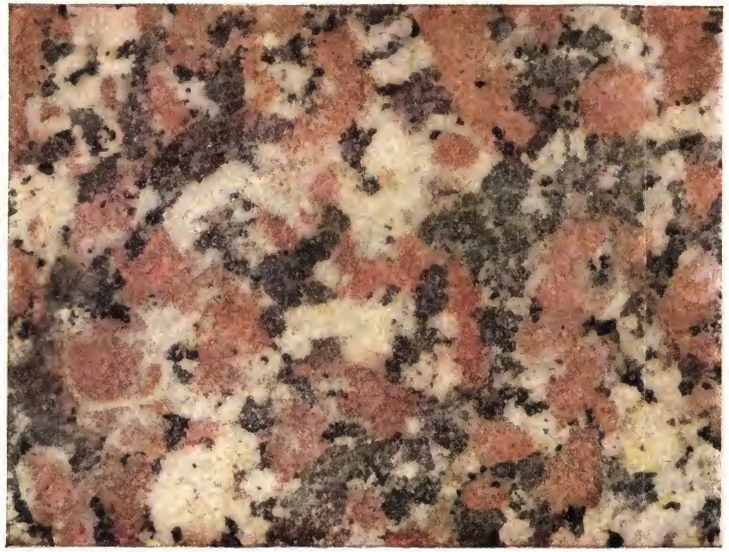
Stones can be cut in any reasonable sizes and can be finished with a variety of surfaces and textures. Marbles offer an infinite variety in colorings, and can be had in any desired sizes. Woods can be cut into slabs and strips and offer beautiful possibilities in color and grain. All these materials can be used in forming beautiful floor and wall coverings, but must in all cases be used with reference to their natural qualities and forms.

Similar limitations occur in most fabricated materials such as brick, tile and linoleum, rubber, and other flooring materials, and the designer must use them with strict regard to their qualities.

9. Cost.—The cost of floor coverings, including the cost of installing them, is often a deciding factor in their selection. The cost is not always considered from the standpoint of the life of the floor. The floor that would have the highest first cost and that would give the best service will often be rejected and an inferior material used to save initial expense.



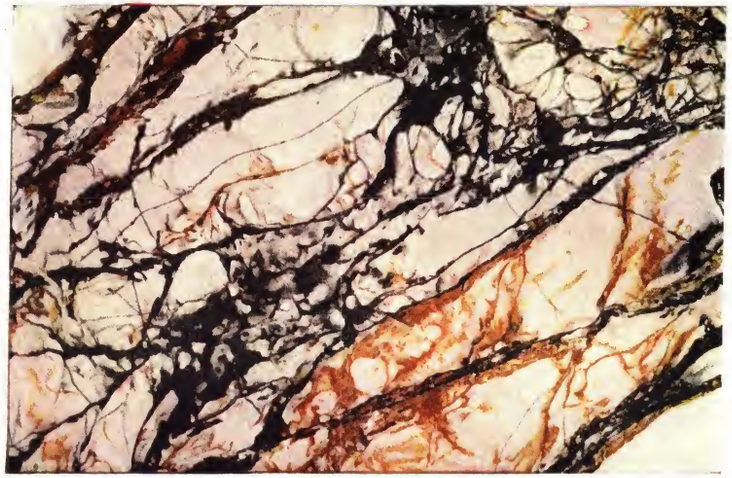
(*a*)



(*b*)

Courtesy of National Building Granite Quarries Association

BB 245 1058-3 BB 279 5375 FIG. 1



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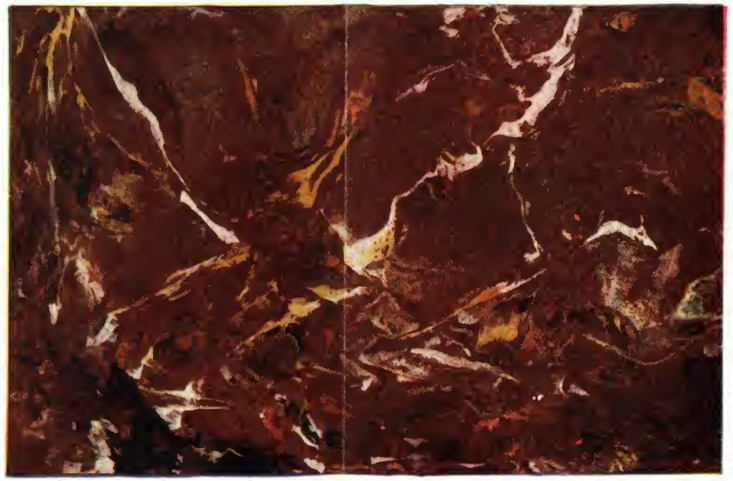


(*b*)

(*c*)

(*d*)

FIG. 3

STONE FLOORS

CHARACTERISTICS AND FINISHES OF STONE

10. Kinds.—Decorative stones used for flooring as well as for walls are found in abundance throughout the United States. They vary greatly in conformation and color, and offer a wide choice. Their natural formation governs the methods of production and finish, and their hardness, resistance to abrasion, color and size limitations, determine the uses to which they are put.

11. Characteristics.—The principal characteristics of stone are permanence and hardness. The hardness is comparative only, as there are both hard and soft stones. Soft stones are those that are easy to work, soft to the tread, and do not have the resistance to wear of the harder kinds.

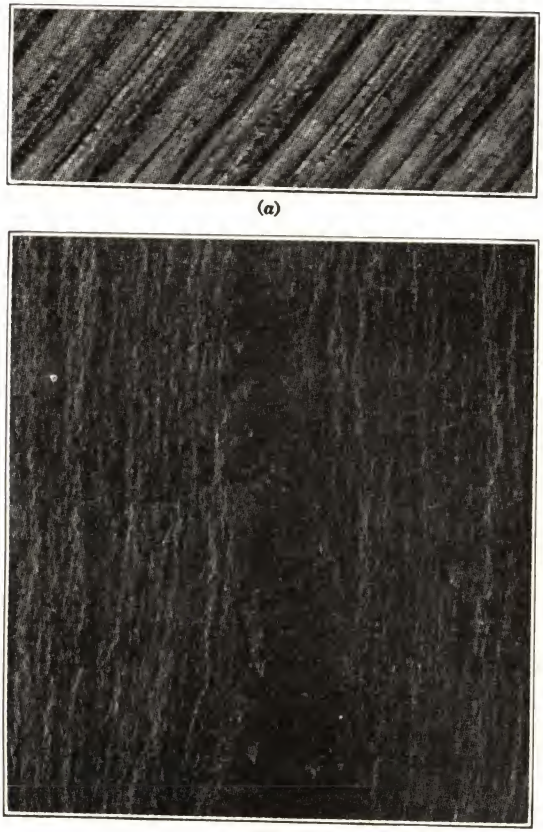
The degree of hardness in stones is established by tests, which make it possible to select a stone of a desired hardness. A stone that has the wearing quality necessary for a private house may not wear under heavy or constant traffic, such as occurs in a railroad station.

Stone, because of its hardness, does not require refinishing after installation. The finished surface is generally permanent and requires no upkeep, except occasional washing and cleaning. Stone is also generally both waterproof and weatherproof. The joints in the stonework are the most vulnerable points and permit water to go through. Unless the joints are carefully filled with the right mortar, much trouble may be experienced.

12. Color.—Stones are extremely varied in their colors, owing to their chemical compositions. A complete uniformity of color is difficult to secure, even in the same block. This is one of the advantages of stone, as the color variation, combined with the methods of finishing, lends charm to the finished floor or wall surface, as shown in Fig. 1 (*a*) and (*b*).

13. Finishes.—The finishes of stones such as marbles and granites, are fairly well standardized and are easily specified. Each finish has an effect upon the surface and color of the stone.

More of the color and variations in marking are noticeable as the quality of the finish becomes finer, until, in the polished finishes, the full beauty of the stone is developed.



(*a*)

(*b*)

FIG. 2

14. Sawed Finish.—Solid, unstratified stones are prepared by being sawed into blocks, which are then sawed into slabs of the desired thickness. The sawing process leaves the stones with a surface somewhat roughened by saw marks, as shown in Fig. 2 (*a*). This finish is often used where it is necessary to have a non-slip surface, as on exterior terraces and on porches.

15. Split, or Cleft, Surfaces.—Stratified stones, such as slate or flagstone, which are formed in layers, are first broken into large blocks by blasting and then split with iron wedges into slabs of the thickness desired. This process leaves a natural split, or cleft, surface, slightly rough in texture, as shown in Fig. 2 (*b*). As in the case of the saw finish, this surface has a non-slip effect.

16. Planed Finish.—A planed finish is secured by planing the sawed or split slabs with a steel plane. While slightly smoother than either the sawed or the split surface, the planed finish shows the marks of the plane in varying degree, dependent on the type of plane used. This surface is also excellent for non-slip floors.

17. Shot Finish.—Shot finish is secured by blowing small shot or sand with an air compressor against the sawed, split, or planed surface. It removes projections and also the greater part of the roughness, producing a fairly smooth finish, and makes an excellent surface for any stone floor where extreme smoothness is not required.

18. Sand-Rubbed Finish.—Sand-rubbed finish is sometimes called machine-rubbed. To produce this surface, the stone slabs are placed on flat beds and large circular steel or carborundum wheels are rotated over them. In this process, the stone is covered with sand, carborundum grains, or small shot, and kept constantly wet. The resulting surface is level and smooth with a slight stipple. It can be used for any purpose for which stone flooring is selected. Examples of sand-rubbed finish are shown in Fig. 1 (*a*) and (*b*).

19. Fine Sand-Rubbed Finish.—Fine sand-rubbed finish is produced by the same process as is used in forming the sand-rubbed surface, but a finer grained rubbing material is used, which results in a smoother surface. Fine sand-rubbed finish is used where a finer surface than sand-rubbed is desired for design or effect.

20. Honed Finish.—A honed finish is finer than a sand-rubbed finish. Fine-grained carborundum wheels or disks are

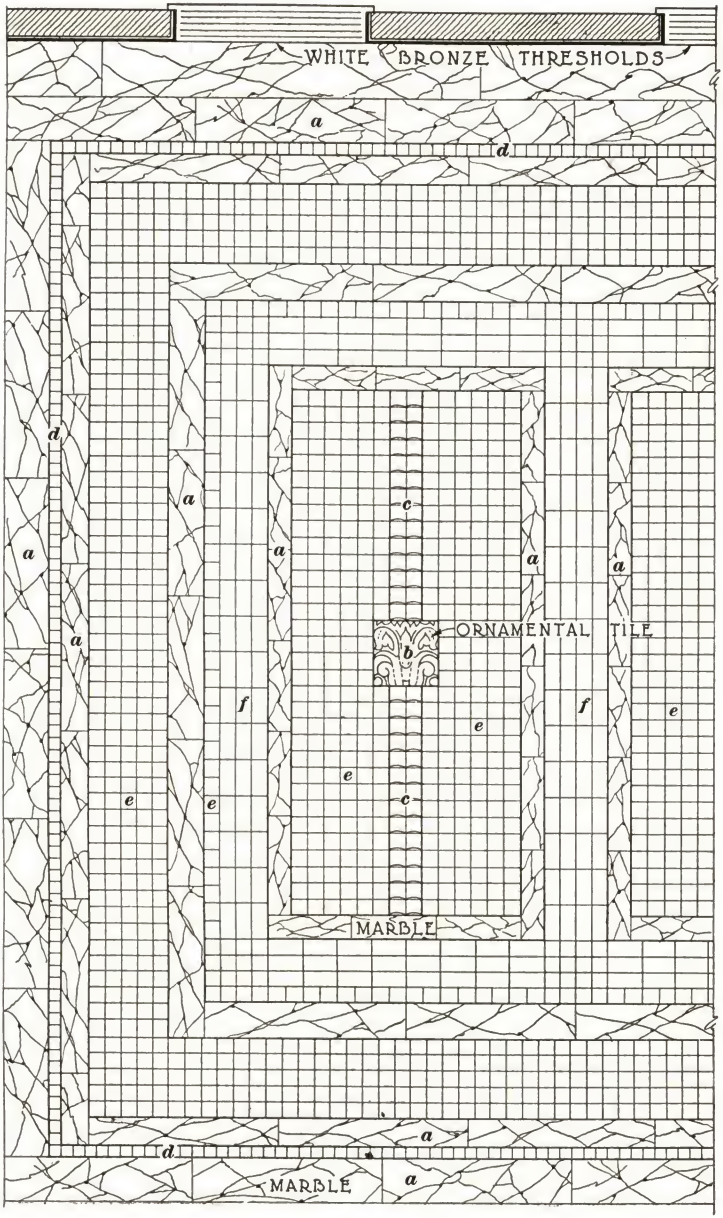

WHITE BRONZE THRESHOLDS
a
d
d
a
a
a
a
a
a
c
ORNAMENTAL TILE
b
f
f
e
e
e
e
e
c
MARBLE
a
d
MARBLE
a

FIG. 4

rotated directly on the stone surfaces, which are kept constantly wet, thus producing a smooth, even, and true surface, without stipple, and velvety to the touch. It is sometimes confused with sand-rubbed, but it is smoother in texture. The honed finish is used wherever a very fine finish is desired, and it is the finest finish that can be secured on stone that cannot, owing to its natural structure, take a polish.

21. **Dusted Finish.**—The dusted finish is used mostly on granite, and is secured by dusting or sandblasting the honed finish with a fine silica or carborundum sand. It gives a very fine eggshell or stippled surface while retaining its velvety smoothness.

22. **Polished Finish.**—Polished finish is the highest and most costly finish that can be given to stones like granite or marble, which are of crystalline formation and have close grains. It is secured by buffing or rubbing the sand-rubbed surface of the stone with felt-covered buffers and a polishing powder, such as oxide of tin. The result is a highly polished, very smooth finish that brings out all the brilliant colors inherent in the stone. This finish is a protection to the stone and is easily cleaned. It is practically never used on floors, but is particularly applicable to wall surfaces. Examples of marble with polished finishes are shown in Fig. 3 (*a*), (*b*), (*c*), and (*d*).

23. **Uses of Stone.**—Stone is largely used for exterior work such as porches, steps, walks, and floors of terraces. For interior spaces it is especially adaptable to lobbies in both public and private buildings, corridors, rooms of monumental design, railroad stations, churches, etc. Stone is also much used in combination with other materials, as in borders and thresholds, or in decorative strips, as shown in Fig. 4. In this illustration are indicated strips of marble *a*, used to divide the floor space into panels that are filled with tiles *b, c, d, e,* and *f*.

GRANITE

24. **Description.**—Granite is a hard igneous rock of a granular composition. It is composed chiefly of feldspar and quartz in combination with mica, and sometimes other minerals,

which give it its color and markings. The texture varies from a coarse grain with large irregular granules, as shown in Fig. 1 (*b*), to very fine grain, as shown in view (*a*).

25. Color.—Different kinds of granites, even pieces from the same quarry, vary greatly in color. Gray is the most common color and varies from a very light shade, almost white, as shown in Fig. 1 (*a*), to a very dark shade. Some granites are distinguished by a warm buff, red, or pink color, and are named after these colors. In Fig. 1 (*b*) is illustrated a red granite. Other colors available are black, a dark mahogany brown, and a combination of rose and black which gives a most interesting effect, especially when polished. Red and green granites are also available in small quantities.

26. Thickness.—When used as flooring, granite is sawed into slabs from $1\frac{1}{2}$ to 2 inches thick, depending on the method of installation. The sizes of the slabs depend on the design and on the facility in handling and setting.

27. Finishes on Granite.—Granite when used for flooring is usually in the sand-rubbed, honed, or dusted finish. In the sand-rubbed finishes, which are most commonly used, three textures are available: rough, medium, and fine sand-rubbed. A sand-rubbed finish that is used on floors is shown in Fig. 1 (*b*). Granite is sometimes used with a sawed finish where a non-slipping surface is desired.

28. Setting.—Being extremely heavy, granite requires a substantial and solid foundation to avoid settling of the stone, and opening of the joints. After setting, granite requires no special treatment or care. It should be thoroughly cleaned of all mortar, cement, etc., and then washed with a soap powder. An occasional cleaning with soap powder is all that is generally required in the way of maintenance.

MARBLE

29. Description.—Marble is perhaps the most commonly used of all stones for flooring, especially on interiors. It consists of natural metamorphic limestone or carbonate of lime in

crystalline form, and is found quite generally throughout the country.

30. Color.—Marble has a great range of color, mostly variegated, because of the presence of streaks or veins running

FIG. 5

in all directions and varying in width, length, direction, and color. The color markings are the distinguishing characteristics of marble and the reason for its great desirability. In Fig. 3 are shown some varieties of color that occur.

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FIG. 6

Courtesy Armstrong Cork Products Co.

31. Finishes.—The most common finish on all kinds of marble used for flooring is fine sand-rubbed. It wears well and gives a certain degree of resistance to slipping. Honed finish is used in cases where a finer finish is desirable and where the traffic is not continuous.

32. Thickness.—The usual thickness of marble slabs for flooring is 1 inch, although thicknesses of $1\frac{1}{4}$, $1\frac{1}{2}$, and 2 inches are sometimes used.

33. Setting and Care.—Marble varies greatly in the absorption of water and it is desirable to use the denser varieties in order to reduce the possibilities of staining. In setting marble, a non-staining type of mortar should be used to avoid discoloration of the marble. In cleaning marble floors, care should be taken that the soap or cleaner used contains no grease or acid, as the former will cause stains and the latter will eventually spoil the fine finish.

34. Uses.—Marble as a floor covering is adaptable to almost any type of room. In color alone it affords almost unlimited possibilities of design. It can be cut to fit almost any space or design, but it is customary to cut it to uniform sizes, such as $6'' \times 6''$, $12'' \times 12''$, $8'' \times 12''$. It is easier to lay small pieces, as they are less liable to crack than large ones.

Marble is the first choice for floor covering in such monumental buildings as museums, libraries, large buildings, entrance lobbies, etc. It may also be used in private homes. In Fig. 5 is an example of the use of marble in the floor of a formal breakfast room of a large home. Marble is also used in the bathrooms and, in small pieces or chips, it is used as the bases for both terrazzo and marble mosaic floors.

TRAVERTINE

35. Description.—Travertine is a crystalline form of limestone. It is found in commercial quantities in the United States only in Montana, Colorado, and the neighboring states.

36. Color.—The colors in travertine are warm, soft tones ranging from a light buff to a fairly dark brown. Some of the colors that occur in this material are shown in Fig. 6.

The most distinguishing characteristic of travertine, and one that adds to its interesting effect, is the series of voids which occur throughout the stone and that appear on the finished surface. These voids range in size from pin points to about $\frac{1}{2}$ inch in length, and do not in any way affect the usefulness of the stone. When a perfectly smooth floor is desired, these voids are sometimes filled with cement that matches the color of the stone.

37. Thickness and Finishes.—Travertine for floor covering is produced in the same thickness of slabs as marble and with the same sand-rubbed and honed finishes. It is generally laid in the same manner as marble, the same precautions being used in setting and in later care. The transverse strength of travertine is small and it should be laid in a full bed of mortar to prevent its cracking.

38. Uses.—The uses of travertine are, in general, the same as those of marble. The texture of travertine is such that it gives a soft and resilient surface, easy to walk on. This quality makes it particularly useful in public lobbies where there is considerable traffic, in waiting rooms in railroad stations, and on stairs.

LIMESTONE

39. Limestone is a fairly hard rock, known for its uniform grain. It is found in large quantities in Ohio, Illinois, Indiana, Alabama, and other states. It is an excellent material for walls, but is not generally used for floors, except in borders, thresholds, etc. When used, it should be of the same thickness as granites, and it should be set with non-staining mortar.

SLATE

40. Description.—Slate is found mostly in the northeastern section of the United States. It is a sedimentary stone formed in layers under tremendous heat and pressure. A characteristic of slate is the ribbons, which are hard veins running irregularly through the material and usually of a different color.

41. Colors.—Slate is found in a number of colors, such as black, green, and purple. The black color is really a dark, bluish-gray, which, when oiled, becomes almost jet black. The green color is a light or medium dark green, whereas the purple is very dark. The last two colors are produced generally in the same neighborhood and the colors are mixed in the same slate,

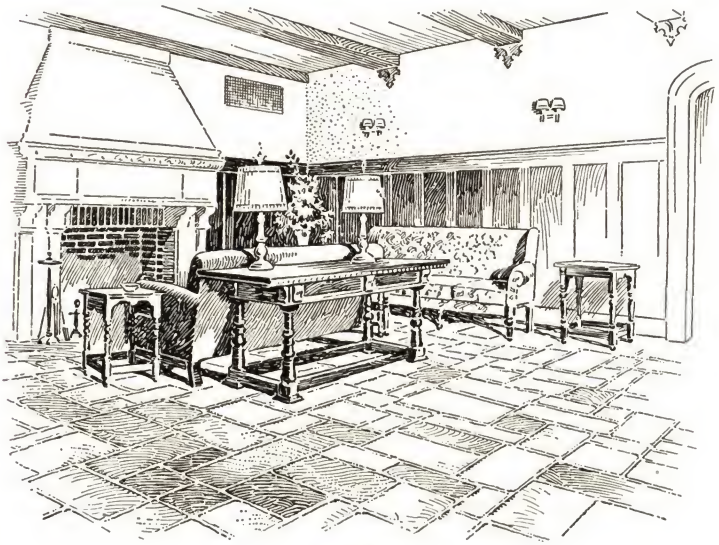


FIG. 7

forming what is known as a variegated green and purple slate. It is also possible to secure a red slate, although its quantity is limited. A characteristic of all of the colored slates is that the color fades evenly when exposed to the weather.

Black slate is divided into two classes, clear stock and ribbon stock. In the clear-stock slate there are no ribbons. Ribbon stock is the more common form and show ribbons or streaks of a darker color. It is used mostly for floors. The ribbons have no effect on the usefulness of the slate and do not affect the finishing. On the contrary, the ribbons, being slightly darker than the main body of the slate, add interest to the surface and texture.

42. Finishes.—Slate is quarried by being sawed into blocks; then the blocks are split with iron wedges into the thicknesses desired. The natural split surface which results from this operation is a fine surface for floor slabs. It is slightly irregular and non-slip in character, as shown in Fig. 2 (*b*). The sand-rubbed and honed finishes are used in interior work.

43. Thickness.—When slate is used as a floor covering it should not be less than 1 inch thick for slabs 12 inches by 12 inches or less in size, nor more than $1\frac{1}{4}$ inches in thickness for larger sizes. It has considerable tensile strength and can be used in thinner slabs than many other kinds of stone.

44. Uses.—Slate can be used for exterior work, such as porch and terrace floors. It can also be used on closed porches, lobbies, vestibules, and similar places, as illustrated in Fig. 7, where it is laid in a random rectangular pattern. Slate is also used for stair treads, as it has a resilient surface, and for borders and spaces where the contrast of black or variegated color is desired.

BLUESTONE

45. Description.—Bluestone is a light-blue, even-grained stone, composed of particles of quartz sand cemented together. Being very dense and extremely resistant to wear, it is especially useful for thresholds, exterior stairs, borders, passages, and places where there is considerable traffic.

46. Finishes.—Bluestone is quarried in blocks, which are sawed into slabs of the required thickness. It is available in sawed, shot, and sand-rubbed finishes.

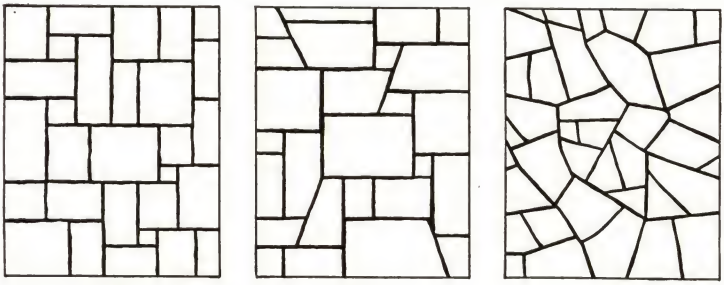
47. Thickness.—The usual thickness of bluestone slabs is 2 inches, although a thickness of $1\frac{1}{2}$ inches is not uncommon. When used in blocks 12 inches square or smaller, bluestone can be as thin as 1 inch.

FLAGSTONES

48. Description.—Flagstones are of two types, one a solid sandstone formation and the other laminated like slate. They are found in widely distributed localities, and each has, therefore, its own peculiarities of color and surface.

49. Colors.—Flagstones occur mostly in blue, gray, brown, and buff, although some other shades may be found. They are mostly variegated in shades of the same color, a feature which adds interest to their appearance. The blues and grays are rather soft in tone, but the browns and buffs in some quarries are almost brilliant.

50. Finishes.—The sandstone types of flagstone are finished in sawed and sand-rubbed surfaces, and occasionally with a honed surface. The laminated type is obtained with split, or cleft, surfaces, as well as sand-rubbed or honed surfaces.



(a) *(b)* *(c)*

FIG. 8

51. Uses.—Flagstones are very desirable for informal walks, especially in gardens. They also form excellent sills and thresholds, and are much used for exterior stairs. On interiors they are used in such places as vestibules, garden and flower rooms, porches, halls, living rooms, and church floors. Commonly used floor patterns are shown in Figs. 8 and 9. In Fig. 8 a rectangular pattern is shown in (*a*), a semi-irregular pattern in (*b*), and an irregular pattern in (*c*). In Fig. 9 is shown a stone pavement in a garden. Two patterns are used in this pavement, the irregular and the rectangular.

52. Thickness.—Flagstones for exterior use are $1\frac{1}{2}$ inches thick, and for interior use 1 inch is sufficient. While some quarries produce the stone in stock sizes, it can be cut into sizes and shapes to fit any design. These stones may be used as borders with fields of other materials.

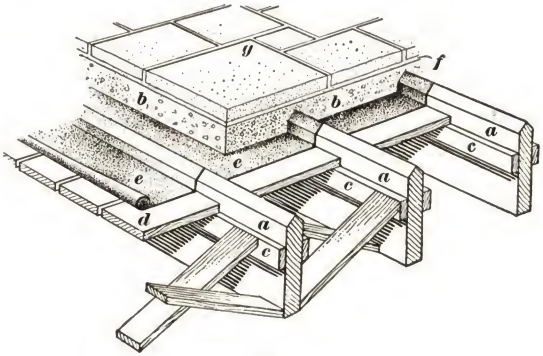
SETTING STONE FLOORS

53. Supporting Bases for Stone-Floor Covering.—There are two common types of bases used for supporting stone floors

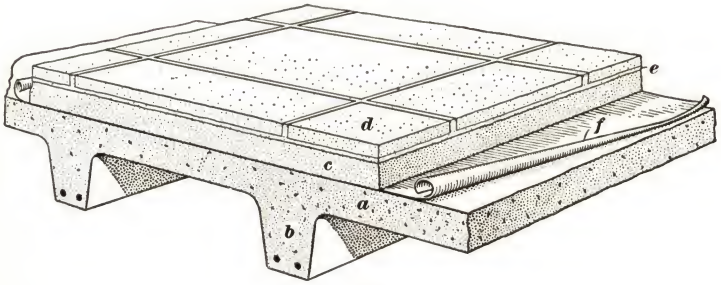
FIG. 9

in building. These are: (1) concrete slabs such as are used in most buildings of reinforced concrete construction and (2) a prepared base of wooden beams, which is used in buildings of wooden construction. A base of the first type is shown in Fig. 10 (*a*), in which a slab of concrete *a* is supported on reinforced

concrete beams *b*. This is the supporting construction. On the slab *a* is laid a layer of concrete or cinder fill *c*. The stone-floor covering *d* is laid on the fill in a bed of mortar *e*. A layer of felt waterproofing *f* may be laid as shown.



(*b*)



(*a*)

FIG. 10

In old buildings where the base must be prepared in wood construction, the wood joists *a* in Fig. 10 (*b*) are chamfered at the top. The tops of the joists *a* should be at least $\frac{3}{4}$ inch below the top of the concrete slab *b*. Wood strips *c* are then nailed to the sides of the joists and a rough wood floor *d* rests on the strips. Over this wooden construction a layer of waterproof paper *e* is laid, and the concrete *b* is placed. This concrete should be a fairly dry mixture, and may have either stone or cinder aggregate. In new buildings, however, the floor *d* should be carried over the tops of the beams, which should be strong enough to carry the construction.

54. Setting Beds.—After the concrete base is thoroughly dry a firm setting bed of mortar *f*, Fig. 10 (*b*), is laid. This is usually a mixture of cement and sand. After the setting bed is placed it is screeded level with a long straightedge, and troweled to a proper distance below the finished floor to receive the stone slabs *g*.

55. Laying of Stone.—The under sides of the stone slabs are first covered with mortar and the slabs shoved into place and tapped down, a wooden mallet being used to avoid injury to the surface. The designs for floors in Fig. 8 are used not only for flagstone but for other stone floors.

Where light-colored marble and stone are used and there is a possibility of the mortar staining the stone, non-staining cement should be used. For some kinds of stones, such as slate and flagstone, standard portland cement mortar is satisfactory.

56. Jointing.—Where the joints are thin and the stones are laid close together, it is customary to butter the edges of the stones with mortar before setting in place, so as to avoid grouting and possibly staining or spoiling the finished surface of the stone. Where wide joints are used, as in flagstone floors, buttering is not necessary, as the mortar can be filled in after the stones are set and leveled, and the surplus mortar is wiped off.

BRICK FLOORS

57. Hard-Burned Brick.—For architecturally designed floors, such as are used in living rooms and porches, where there is little traffic and where wear is not a major consideration, any good, hard-burned brick is acceptable. The selection is based on color, texture, and effect. For such floors the same range of colors is available as in face brick, but it is desirable to select only those kinds having fairly smooth surfaces in order to secure floors that are easy to walk on and easy to clean.

58. Paving Brick.—Where resistance to wear is necessary, paving brick is used. It is made of dense clay and is well burned to secure a hard, impervious surface. Paving bricks are gener-

ally the same size as the standard building bricks, $8'' \times 3\frac{3}{4}'' \times 2\frac{1}{4}''$, but they are also made in $1\frac{3}{4}$- and $2\frac{1}{2}$-inch thicknesses. They have straight edges and faces, so that close joints are possible.

59. Vitrified Brick.—Vitrified bricks are treated with a salt solution before they are burned in the kiln, and have a very hard surface that will not absorb water. They are made in steel

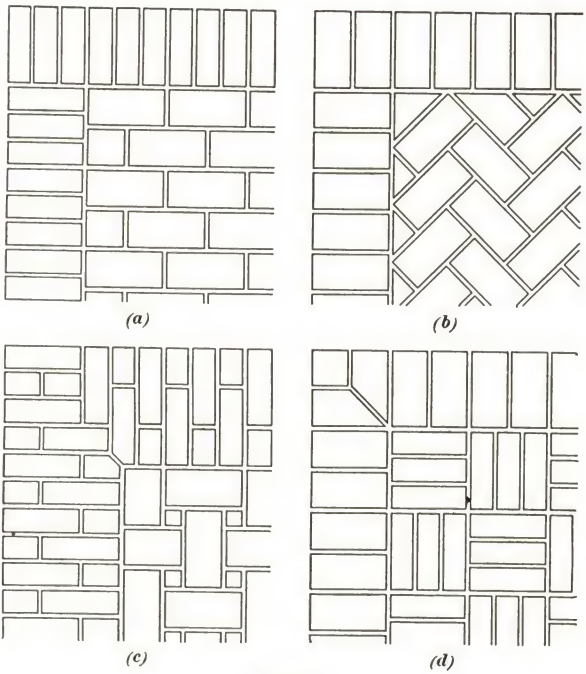


FIG. 11

molds, have straight edges and surfaces, and are much used for sidewalks, paths, and exterior walks surrounding public buildings.

60. Colors.—The majority of bricks used as floors are of a reddish shade, although some buff and gray colors are used.

61. Design.—Brick flooring can be laid in any number of patterns. Four patterns in common use are shown in Fig. 11. These patterns are: (*a*) the *straight* or *common bond,* with the

flat faces of the bricks up, and a border of bricks on edge; (*b*) the *herring-bone pattern,* with the flat faces of the bricks up and border as shown; (*c*) the *basket weave,* with the flat faces of the brick up and a 12-inch border of bricks on edge; (*d*) the *block pattern,* with the bricks on edge and the border laid with bricks with the flat faces up. Other bonds, such as Flemish and garden, are also sometimes used, but they are mostly confined to wall work. Brick in flooring is also often used in combination with other materials forming borders, bonds, and patterns.

62. Laying Brick Floors.—The best method, in laying brick, is to spread a setting bed of cement and sand mortar on top of the concrete fill, and level the bed to receive the brick. After mortar has been spread on the edges or faces of the bricks, the bricks are placed on the setting bed and tapped into place. The joints should then be scraped off, using a trowel in order to secure a flush, level joint.

It is not usual to grout joints in brick flooring except where vitrified bricks are used. Mortar will adhere to rough brick surfaces and can never be satisfactorily cleaned off. For this reason, great care should be taken to avoid getting mortar on the exposed faces of the bricks.

63. For exterior pavements, it is customary to place a sand bed about 2 inches thick under the brick, and to lay the brick on this bed, and fill the joints between the bricks with sand. This gives a certain resilience to the paving and permits rain water to percolate through the joints and keep the walk dry. It is not possible by this method to maintain an even, true surface, but the irregular effect of the surface is interesting.

64. Brick Joints.—The average joint is from $\frac{1}{2}$ to $\frac{3}{8}$ inch thick. Where usage will be severe and where vitrified or paving brick with very straight edges are used, the joint can be reduced to $\frac{1}{4}$ inch. Jointing mortar is usually a cement and sand mortar, the same as is used for the setting beds, although in many cases a small amount, about 10 per cent by volume of the cement, of lime putty is added. This makes the lime mortar easier to work.

CEMENT FLOORS

65. Definition.—The term *cement floor* is used to define a floor having a concrete base or body and a top or finished surface consisting of cement and sand. In discussing cement floors under the heading Floor Covering, the surface finish is of the most interest. The finished or top coat may consist of cement, sand, or crushed stone, and coloring material, which is to produce an artistic floor surface. The top surface may be applied on top of a concrete base that has set and become dry, or may be applied to the bed or base while the base is still wet. This latter method is called the *integral method* of finishing floors.

66. Color.—Architectural effects in color and pattern may be obtained by coloring the top or finishing coat of cement mortar and by dividing it into shapes and patterns of different colors.

Color effect in cement floors is secured either by mixing the color directly in the top coat or by applying it like paint after the floor is finished and dry. In the integrally mixed method, the color is placed in the mix for the top coat. The colors should consist of mineral pigments. A satisfactory result is generally obtained if the pigments are added to the cement before either the aggregate or the water is added. In some cases the top coat is applied in two layers, the bottom layer being the plain uncolored mix. Color is used only in the top layer, which should be not less than $\frac{1}{4}$ inch thick.

In applying either paint or stain to produce the color after the floor has been laid, the surface should be clean, dry, and free from oil, plaster, lime, or other stains.

When staining the floor for color, stains formed of inorganic dyes are generally used, and interesting mottled effects are obtained.

Before applying paint, the floor should be given a priming coat of zinc sulphate dissolved in water, which should be allowed to dry thoroughly, and the surface brushed free of crystals. The paint is then applied in not less than two coats for permanent

results. The directions of the paint manufacturers should be followed in the application of a manufactured paint. It has been found that a satisfactory type of paint for this purpose is composed of pure linseed oil or hard-drying varnish mixed with abrasion-resisting pigments of the desired color. The first coat is generally thinned with turpentine or similar thinner to secure more penetration. The final coat or coats are applied without dilution.

67. Finished Waxing.—In living spaces the cement floor, whether colored or not, is generally given one or two coats of a standard floor wax, which is well rubbed and polished. This gives a dull polish and makes the surface readily cleanable and less liable to dusting or sanding.

68. Floor Hardeners.—Cement floors are often improved by the use of hardeners, the purpose of which is to make the mixture more dense and, therefore, more resistant to wear. Hardeners may be secured in both liquid and powder form and may be used either integrally, mixed with the finished coat, or applied after the floor is laid and dry. In any case, the directions of the manufacturers producing the particular kind of hardener should be carefully followed.

69. Designs.—Cement floors can be laid in almost any pattern, requiring only that there be the proper spacing of the divisional joints and a pleasing arrangement of the colors. Color separation is generally secured by placing wood or metal strips on the base and then pouring the proper colored top mixture into each space. The entire floor should be leveled off and troweled, care being taken to avoid running the colors together.

Tile effects can be secured by cutting false joints in the top coat of cement as it is being troweled. These joints may be thin, requiring no filling mortar, or may be cut wide enough so that they can be filled with mortar after the floor is dry, producing the effect of mortar joints in tile work.

70. Concrete Tile.—Precast concrete tiles are being used today. They are made in the normal concrete color and in other colors, mostly in shades of red. Being formed in metal or wood forms, they can be cast in different sizes and shapes

FIG. 12

to fit definite spaces. The customary method is to use sizes similar to those used in clay tiles.

Concrete tile has a fairly smooth surface and texture. It is used a great deal for exterior floors, porches, and vestibules.

FIG. 13

TILE FLOORS

KINDS AND MANUFACTURE OF TILES

71. Composition and Use.—Tiles, as described in this lesson, are made of clays or combinations of clays mixed with mineral ingredients to obtain a variety of colors. This mixture

is wetted and molded into many different shapes and sizes, and then burned in a kiln until each tile or tile square becomes one homogeneous mass.

Examples of the use of floor tiles to form different patterns are shown in Figs. 12 and 13. In Fig. 12 the floor has a field of square tiles laid diagonally and a border of tiles of different patterns. The treads and risers, as well as the niche and its enclosing wall, are also covered with tiles, those in the niche being ornamental in design. In the floor shown in Fig. 13 the basket pattern is used, while special forms of tiles are used in facing the mantel.

By its very nature tile has a hard wearing surface which makes it particularly adaptable for use as flooring.

72. Methods of Production.—Tile is produced by the plastic or by the dust-pressed method.

Plastic Method.—In the plastic method of production the clays are ground, mixed with water, and then formed in molds either by hand or by pressing through machines. When dry, the tiles are placed in kilns and fired under high temperatures. Owing to the effect of the heat on the clay, a certain slight warping in surface and shape results, which gives interesting effects when this type of tile is used.

Dust-Pressed Method.—In the dust-pressed method the clays are first ground fine, mixed with water, and then pressed dry. This dry mass is again ground fine and then pressed into shapes mechanically in metal forms, which are placed in the kilns and fired. The result is a tile with an even, uniform surface, and but little irregularity in form.

73. Glazing of Tile.—When first fired by either method, the resulting product is called the biscuit, or body. When the finished tile is produced by this one firing, the tile is known as unglazed tile. Glazed tile is produced by coating the biscuit, or body, with a liquid glaze and again firing it. This second firing causes the glaze to fuse with the body. It takes several coatings and firings to produce the desired effect, especially if a variegated or crackled surface is desired. Glazing produces a hard, impervious surface, resistant to most stains and acids.

74. Hardness, or Vitrification, of Tile.—In the production of tile, the hardness, or vitrification, of the body, or biscuit, has an important effect on the use of the various kinds of tile, and also governs the texture of the surfaces and the kinds of finishes and colors which can be applied. There are four degrees of vitrification in which the tile is produced, which are measured by the amount of water that the finished tile will absorb when thoroughly soaked in water.

Table I shows the percentage of water absorbed for each degree of vitrification of the tile, according to the practice generally accepted by the tile industry. It will be noted that impervious tile absorbs practically no water.

TABLE I

PER CENT OF ITS WEIGHT OF WATER THAT CAN BE ABSORBED BY VITRIFIED TILE

Degree of Hardness	Per Cent of Its Weight of Water That Can Be Absorbed
Impervious	Less than 0.5
Vitreous	From 0.5 to 3.0
Semi-vitreous	From 3.0 to 7.0
Non-vitreous	From 7.0 to 15.0

The first three types of tile listed in Table I are considered as best adapted for floor surfaces. Each of the groups, glazed and unglazed, is made in a number of classes and sizes, which are described in the following pages.

GLAZED TILE

75. General Classes.—Glazed tile may be divided into two kinds known as glazed, or bright glaze, describing tiles with a bright enamel glazed finish; and dull, or matt, glaze, describing those with flat or dull glazes in varying shades of brightness. Glazed tiles of both kinds are produced in plain colors, polychrome, and mottled colors, and the surfaces may be clear, stippled, or crackled in effect. The resistance of these tiles to wear is largely dependent on the body on which the color is

placed. In the case of floor tile, the dull glazes are more durable than the bright.

76. Classes and Sizes of Glazed Tiles.—Glazed tiles are classified, and their customary sizes given, in Table II.

TABLE II

CLASSES AND SIZES OF GLAZED TILE

Glazed	1. Bright Glaze	2. Dull, or Matt, Glaze
Classes	Sizes	
Interior tile	6″×12″, 6″×9″, 6″×6″, 6″×3″, 3″×3″, 4¼″×4¼″	
Weatherproof tile	6″×6″, 6″×3″, 3″×3″, 4¼″×4¼″	
Ceramic mosaic tile	2″×2″, 2″×1″, 1″×1″, 1½″×1½″, 1½″×1¾″, ⅜″×⅜″	
Ceramic mosaic tile	Hexagons—1″, 1¼″, 2″ sizes	
Ceramic mosaic tile	Pentagons—2 3/16″ sizes	
Faience tile	12″×12″, 8″×8″, 6″×12″, 6″×9″, 6″×3″, 3″×3″, 4¼″×4¼″, 4¼″×2″, 2″×2″	
Faience weatherproof tile	Same as faience tile	

Glazed interior tiles have an impervious glaze on the face which is applied on a non-vitreous body. These tiles are from ¼ to ½ inch thick. They are produced generally by the dust-pressed method and their use is practically confined to interior wall coverings.

Glazed weatherproof tiles have an impervious glaze on a vitreous or semi-vitreous body, and are generally ½ inch thick. They are also sometimes known as glazed vitreous tiles. They have been developed especially for use where there is exposure to freezing weather in the presence of water, as in outdoor swimming pools, refrigerating rooms, exterior lobbies, porches, and terraces.

Glazed ceramic mosaic is the term specifically applied to small units less than 6 square inches in area in the face and from ⅜ to ½ inch thick. This tile is usually mounted on sheets of paper at the factory, each sheet containing about 2 square feet of tile, including the jointing. Installing the tile at the build-

ing is thus made easy, as otherwise each tile would have to be laid singly.

Faience tiles have an impervious glazed face on a vitreous body, and are generally produced by the plastic method. This tile has a rugged, artistic surface and is used mostly where architectural effects are desired. The edges generally vary from the straight, and the glazed deposit is heavier at those edges, giving an irregular but interesting effect. The usual method of manufacturing faience tile is to form the biscuit, or body, by hand, although this should be clearly specified when a selection of faience is made.

The standard thickness of faience is not less than $\frac{1}{2}$ inch, but in the small units of less than 6 square inches on the face, they may be $\frac{3}{8}$ inch in thickness. Faience tile is produced also in what is known as *weatherproof faience tile,* which is used for the same purposes as the weatherproofed glazed tile.

Faience tile can be used for every purpose for which tile is used, including floorings, walls, trim, walks, decorative bands, swimming pools, showers, and laboratories.

UNGLAZED TILE

77. Composition.—Unglazed tile is made in porcelain, natural clay, and non-slip abrasive bodies.

Porcelain tile is made in impervious, vitreous, and semi-vitreous bodies, by either the plastic or the dust-pressed method. Porcelain tiles have a very fine texture and the face and edges are sharp and clear.

Natural clay tile is produced in impervious, vitreous, and semi-vitreous bodies, by either the plastic or dust-pressed methods. The face of the tile presents a somewhat rugged effect, with medium to large-sized grains showing, but the body is dense and the surfaces and edges are clean and sharp.

Non-slip abrasive tiles are the same as the porcelain tiles, except that abrasive grains, such as carborundum or alundum, are added, causing a rugged surface appearance. The edges are reasonably true, but are not so precise as in the porcelain or natural-clay types.

78. Sizes and Uses of Unglazed Tiles.—The customary sizes of unglazed tiles are given in Table III.

Unglazed ceramic mosaic tile includes all sizes of unglazed tile less than 6 square inches in surface area, and from $\frac{3}{8}$ to $\frac{1}{2}$ inch thick. They are made in the shapes of squares, hexagons, and pentagons and are usually mounted on paper at the factory, and are much used in bathrooms, kitchens, and shower baths. The numerous joints are an advantage in reducing the slipperiness of the floor when wet. They are produced in all three of the unglazed types, and are applied in the same manner as glazed ceramic mosaics.

TABLE III

CLASSES AND SIZES OF UNGLAZED TILE

Unglazed—1. Porcelain 2. Natural Clay 3. Non-Slip or Abrasive

Classes	Sizes
Ceramic mosaic squares	2″×2″, 2″×1″, 1″×1″, $\frac{1}{2}$″×$\frac{1}{2}$″, 1$\frac{1}{2}$″×1$\frac{1}{2}$″, 1$\frac{1}{2}$″×$\frac{3}{4}$″, $\frac{3}{8}$″×$\frac{3}{8}$″
Ceramic mosaic hexagons	1″, 1$\frac{1}{4}$″, 2″
Ceramic mosaic pentagons	2$\frac{3}{16}$″
Paver tile	6″×6″, 6″×3″, 3″×3″, 4$\frac{1}{4}$″×4$\frac{1}{4}$″
Quarry tile	12″×12″, 9″×9″, 6″×3″, 3″×3″, 4$\frac{1}{4}$″×4$\frac{1}{4}$″, 2″×2″, 1″×1″
Hand-made	12″×12″, 8″×12″, 6″×12″, 9″×9″, 6″×3″, 3″×3″, 4$\frac{1}{4}$″×4$\frac{1}{4}$″, 4$\frac{1}{4}$″×2″, 2″×2″

Paver tile includes all unglazed tile except quarry tile and hand-made tile having a surface area of 6 square inches or more. Paver tiles are usually not less than $\frac{1}{2}$ inch thick. They are laid individually and are produced in all three types of unglazed tile. They are particularly adaptable for flooring.

Quarry tile is that made principally from a combination of clay and shale by the plastic method, either by mechanical extrusion or by hand pressing. The body is very dense and the tile has irregular edges with a rugged hand-made appearance. Color is secured by using certain combinations of clay, and is restricted mostly to red, buff, brown, black, and grays.

The faces are either plain, of uniform shade, or burned in such a way that the edges become harder and darker. This burning process is called fire-flashing. Quarry tile is made not less than ½ inch in thickness. It is much used for flooring, and is especially well fitted for exterior use.

Hand-made unglazed tiles have plastic bodies, formed entirely by hand, and are ½ inch or more in thickness. They are used in floors where architectural effects are desired, and they present interesting irregular surfaces and edges. These tiles are handled and set in the same manner as faience tile.

GRADING, COMBINING, AND INSTALLING TILE

79. Grading.—The grading of tile has been definitely established by the National Bureau of Standards, U. S. Department of Commerce, which has fixed the minimum requirements for each physical grading. These grades vary for the different classes of tile.

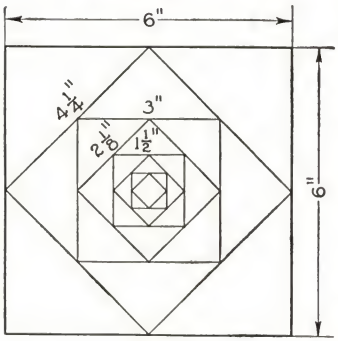


FIG. 14

For all glazed tile except faience, and for unglazed tile except quarry tile, there are two grades, standard and seconds. Faience tile, being hand-made, are more difficult to classify and it is left to individual judgment, based on the requirements of the installation, to decide what is the standard grade and what second.

Quarry tile is divided into three grades; standard, seconds, and perfected. The perfected grade includes selected standard tiles which have had the edges ground to size so that they may be laid with a very close joint.

80. Combining Various Shapes and Sizes of Tile.—Tile shapes in nearly all cases follow geometric patterns, such as squares, oblongs, hexagons, pentagons, etc., and there are also some circular tile shapes available in small sizes.

The basis of tile sizes is a $6'' \times 6''$ square. From this size, gov-

erning dimensions for both smaller and larger sizes are developed, as illustrated in Fig. 14. As a result of this system, the standard sizes have been worked so that, whatever different sizes are fitted together, they form patterns with uniform joints without cutting, as shown in Fig. 15 (*a*) to (*f*). Pattern (*a*) consists of $6'' \times 6''$ squares and $3'' \times 3''$ squares. Pattern (*b*) is made of regular hexagon tile. Pattern (*c*) is composed of $4\frac{1}{4}'' \times 4\frac{1}{4}''$, $4\frac{1}{4}'' \times 2''$, $2'' \times 2''$, $2'' \times 1''$ and $1'' \times 1''$ pieces.

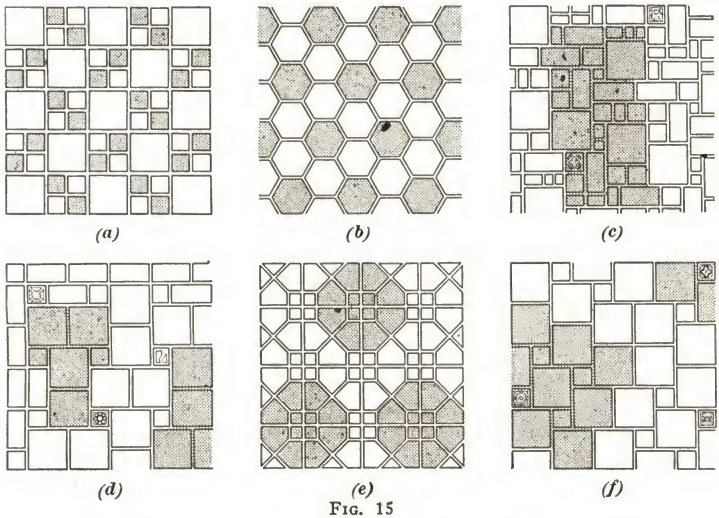


FIG. 15

Pattern (*d*) is formed of $4\frac{1}{4}'' \times 4\frac{1}{4}''$, $4\frac{1}{4}'' \times 2''$, and $2'' \times 2''$ pieces. Pattern (*e*) is an arrangement of square tiles and half-long hexagons. Pattern (*f*) is an irregular layout of $6'' \times 6''$ and $3'' \times 3''$ squares.

81. Installation of Tile Flooring.—In most cases the tile is laid on a concrete foundation or base. When the building is of a reinforced-concrete floor construction, the structural floor slab sometimes acts as the foundation and the tile may be laid on it in mortar.

Usually, a separate concrete fill is installed after the structural floor has been built, as shown at *c* in Fig. 10 (*a*). This

fill should not be less than 2 inches thick if of stone concrete, and 3 inches if of cinder concrete. When laid directly on the ground the thickness of the fill should be at least 1 inch more, and it should be reinforced with an expanded metal-wire mesh. In wood construction, a concrete fill is formed between the wood joists as shown in Fig. 10 (*b*).

82. Mortar Setting Bed.—When dry, the fill is thoroughly cleaned and moistened; then the mortar setting bed is spread over it and the tile is laid. This bed, composed generally of 1 part cement and 3 parts sand, is spread evenly to the level required to bring the tile to the correct floor level. The thickness of the tile governs the thickness of this bed, as shown in Table IV.

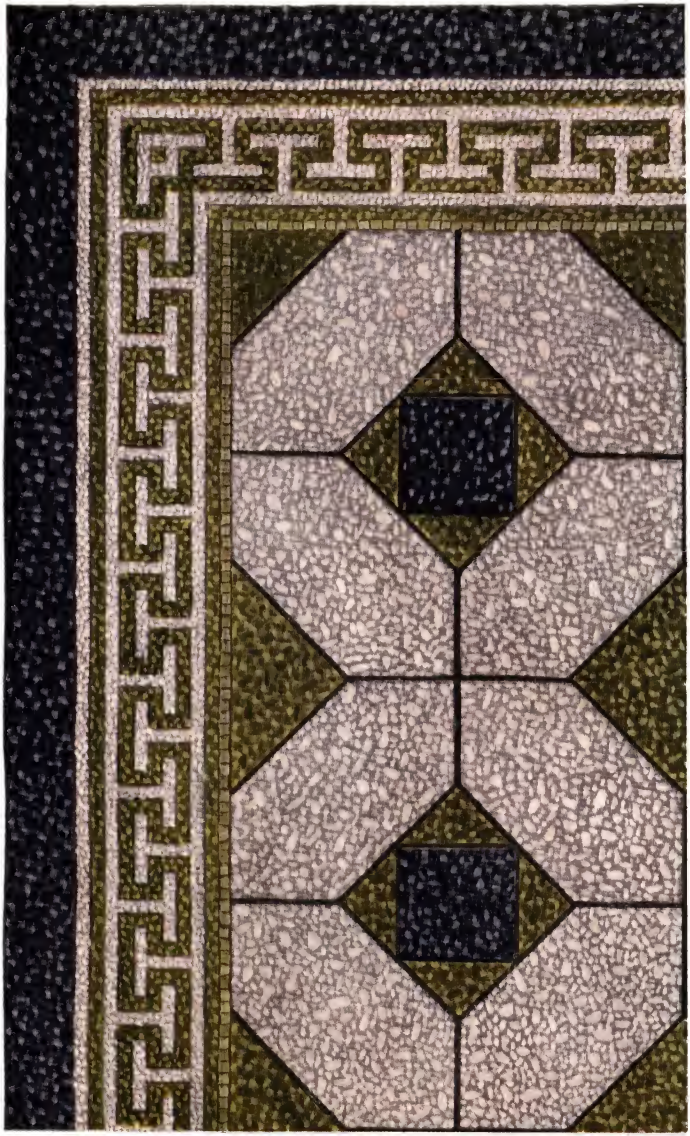
TABLE IV

THICKNESS OF MORTAR BEDS FOR TILE

Thickness of Tile Inches	Thickness of Mortar Bed Inches
$\frac{1}{4}$ to $\frac{1}{2}$	$\frac{3}{4}$ to $1\frac{1}{4}$
$\frac{1}{2}$ to 1	1 to $1\frac{1}{4}$
Over 1	$1\frac{1}{4}$ minimum

83. Placing the Tile.—The top of the setting bed, while wet, is dusted with neat portland cement, and the tiles are then placed in position, pressed firmly into place, and tamped level before the initial set has taken place in the setting bed. All types of tile, except the non-absorbent types and those mounted on paper at the factory, must be thoroughly soaked in water before they are set. This prevents the tile from absorbing water from the mortar setting bed, which weakens the mortar so that the tile will not adhere properly to the bed.

When the mortar bed has set firmly, the paper backing in the ceramic mosaic types of tiles and the excess mortar in all individually set types, are removed. The joints between the tiles are then filled, either by grouting or by placing mortar with a trowel, depending on the width of the joints. Next, the joints



Serial 5375

FIG. 16

Courtesy Armstrong Cork Products Co.

are rubbed or troweled smooth and level and sprinkled with dry cement while wet, to take up any voids on the surface. Before the jointing mortar has completely hardened, all excess cement is washed off, leaving the floor clean.

84. Cleaning Tile Floors.—After the mortar in the joints has set thoroughly, the tile is again washed. Unglazed hand-made and quarry types are sometimes given a light coat of linseed oil, applied with a rag to bring out the color and texture.

85. Joints in Tile Work.—Quarry, faience, and colored glazed tile usually have jointing as determined by the floor

TABLE V

SIZES OF JOINTS FOR TILE FLOORS

Kind of Tile	Width of Joint, Inch
Ceramic tile, mounted, in small pattern	$\frac{1}{16}$ to $\frac{1}{4}$
Ceramic tile, unmounted, in small pattern	$\frac{1}{8}$ to $\frac{1}{4}$
Flint and paving tile	$\frac{3}{16}$ to $\frac{1}{4}$
Faience and hand-made types	$\frac{1}{4}$ to $\frac{1}{2}$
Quarry tile	$\frac{3}{8}$ to $\frac{1}{2}$

design. Ceramic mosaic types are generally laid with close joints. In Table V are shown the customary widths of joints for the various types of tile.

TERRAZZO FLOORS

86. Composition.—Terrazzo consists of small chips of marble or of granite or other hard stones, known as aggregates, which are mixed with cement and applied as a top finish over a base of concrete. The floor takes the color of the cement and the aggregates that are used. Numerous fine color effects are therefore obtained by the use of various colored marbles as aggregates. The cement mortar is also sometimes colored, adding to the possible effects. In Fig. 16 is shown the use of different colors in a patterned terrazzo floor as well as the method of outlining the pattern, as is usually done, by separat-

ing the colors by means of metal strips. The strips are here indicated by the dark lines.

87. Uses.—Terrazzo floors are very desirable in spaces where constant cleaning, wear and tear, and a sanitary floor are required. Spaces such as corridors, wash rooms and toilet rooms, hospital operating rooms and laboratories, are typical. Where a non-slip surface is required, powdered grains of such minerals as carborundum, alundum, or bronsalum are added to the top mixture, producing a rough top surface in which the grains prevent slipping.

88. Aggregates.—The sizes of aggregates generally used for terrazzo are given in the accompanying tabulation. The sizes Nos. 1 and 2 are the most commonly used. These sizes being so small, it is possible to produce them from the waste in cutting marble slabs. They are available in almost every type and color of marble.

SIZES OF AGGREGATES FOR TERRAZZO FLOORS

Size No. 0: passes on a $\frac{1}{8}$" screen and remains on a $\frac{1}{16}$" screen
Size No. 1: passes on a $\frac{1}{4}$" screen and remains on a $\frac{1}{8}$" screen
Size No. 2: passes on a $\frac{3}{8}$" screen and remains on a $\frac{1}{4}$" screen
Size No. 3: passes on a $\frac{1}{2}$" screen and remains on a $\frac{3}{8}$" screen

89. Matrix.—The matrix is the mortar in which the aggregates are mixed to produce the floor. In some cases a close, firm pattern with a larger percentage of chips is desired, and in other cases the proportion of chips is less, and more of the matrix appears on the surface. A white, stainless cement is generally used in forming the matrix, and this can be colored if desired. Where a dark gray color is wanted, standard portland cement is used.

90. Gypsum Matrix.—A type of terrazzo flooring is produced by the use of gypsum instead of cement in the matrix. This forms a resilient flooring, but it does not have the resistance to hard usage which results from the use of a cement matrix. This type is, however, very satisfactory in such places as cafeterias and small lobbies, where the traffic is not too heavy. Strips must also be used in this type, which otherwise is applied in the same manner as a cement matrix.

91. Method of Laying Terrazzo Flooring.—The base under terrazzo flooring must be very substantial if future cracking is to be avoided. The preparation of the base or fill over wood or concrete is the same as for tile and is illustrated in Figs. 10 and 17.

On a concrete slab or fill there is first placed a $\frac{1}{4}$-inch layer *a* of fine sand, as illustrated in Fig. 17, over which layers of tar paper *b* are laid. On this is placed the under-bed *c*, which is composed of 1 part cement to 4 parts of coarse sand or cinders mixed with water. If this under-bed is less than $1\frac{1}{2}$ inches

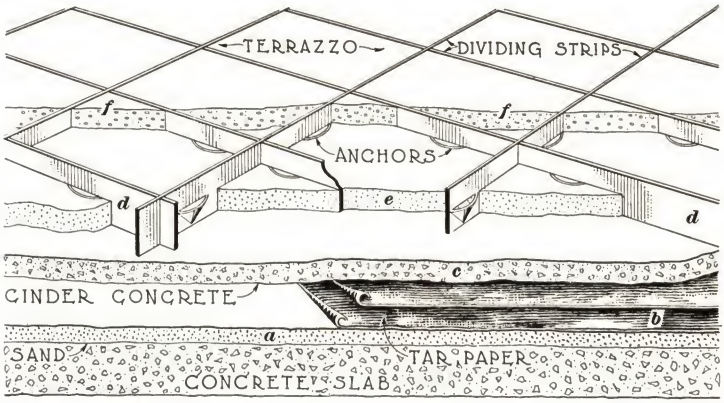


FIG. 17

thick it should be reinforced with a thin wire mesh. As soon as this under-bed is laid, screeded level, and rolled, metal strips *d* should be placed so that the top of the strips will be at the level of the finished floor.

92. Terrazzo Dividing Strips.—The dividing strips, which are used in terrazzo flooring for separating colors and for overcoming any possibility of shrinkage in the top coat, are usually of some non-ferrous metal, such as brass, aluminum, bronze; or nickel-bronze. In all cases, the strips, when set, must go through the full thickness of the top coat.

When the strips are placed and leveled, a finishing or terrazzo coat is placed, which should not be less than $\frac{3}{4}$ inch thick. This top coat is sometimes placed in two layers, as shown in

Fig. 17, the lower coat *e* being placed first. The top coat *f* is set carefully between the strips, separating the colors, to carry out the pattern. It is then troweled into place, leveled off, and any excess material removed. Next, it is rolled level with a heavy roller pushed by hand, care being taken to avoid the running of one color into the other.

93. Finishing of Terrazzo Flooring.—When the finish coat of mortar *f* is sufficiently hard to prevent defacement, it is ground with coarse carborundum, generally set in an electric-powered machine operating with a rotary motion. This first operation grinds the marble and cement, producing a thick mud known as *pacchiarina,* which is washed off before the next operation.

A thin coat of cement grout of the same color as the matrix is then put over the flooring and allowed to set until the final grinding. This grout fills all of the pores and voids, and makes a solid flooring. The flooring is then thoroughly wet again and ground with a fine carborundum stone until a fine, semi-polished surface is obtained. At the corners of the wall and the flooring, and in any coved or vertical work, this grinding must be done by hand. The terrazzo is then thoroughly washed and requires no more attention other than cleaning as required. In the examples of terrazzo flooring in Figs. 16 and 18 are shown the brass dividing strips and the different colored sections of terrazzo work. A mosaic tile border is set in the terrazzo pattern.

94. Precast Terrazzo.—Terrazzo is sometimes precast at the shop, especially when used as door thresholds, stair treads and risers, coves, bases, etc. In this form it is also used as wainscoting.

Precast terrazzo is made by the same general method as when it is finished in place, the material being poured into molds and finished in the same manner. At the building, precast terrazzo is set in mortar as are slabs of marble.

95. Art Marble Flooring.—Art marble flooring is made of the same general composition as terrazzo, except that, instead of using small marble chips mixed with a matrix, pieces of

BB 279—5373 *Courtesy National Terrazzo and Mosaic Co.*

FIG. 18

marble of odd and irregular sizes are used. These are individually set in the flooring in mortar, and are then ground or rubbed smooth. Sometimes the pieces of marble are set and the mortar is poured around as a grout. This type of flooring is much used to form bathroom or sunroom flooring in inexpensive homes where a colorful effect is desired.

MOSAIC FLOORS

96. Description.—A mosaic floor consists of small cubes laid in a pattern, which is formed by the colors of the various materials used for the cubes. In most cases these cubes are of marble, but glass and small ceramic tile are also used. The distinctive feature of mosaic flooring is in the effect secured through the cubes being laid individually and entirely by hand, so that there is an absence of a mechanical appearance. In Fig. 18 is shown a terrazzo floor in which borders of mosaic work are used to outline the various patterns.

97. Uses.—Mosaic forms a hard, long-wearing floor, and the many joints make it almost completely non-slipping in character. Being quite expensive when properly installed, mosaic flooring is used mostly in rooms of special design. Lobbies in public buildings, chapels, monumental rooms, etc., are some of the places to which mosaic flooring is particularly adaptable.

98. Cubes, or Tesserae.—The cubes used for mosaic flooring are called *tesserae*. They vary in size from $\frac{5}{8}$ to $\frac{3}{4}$ inch square. They are cut mostly by hand and, in the case of special designs, are cut into the various shapes required to carry out the pattern. In mosaic flooring the human figure, trees, flowers, and paintings can be imitated.

In very complicated work, such as human figures, where there are many unusual shapes and sizes, the tesserae are sometimes individually pasted to a paper back before setting on the floor, in order to make certain that the design will be carried out. The paper is attached to the exposed surface of the mosaic and must be washed off after the mosaic has been set, in the same manner as for ceramic mosaic.

SPECIAL FORMS OF FINISHED WOOD FLOORING

99. Wide Plank Flooring.—Wide plank flooring is used only for the finished surface effect, where it is desirable to carry out the design of a period, such as an early colonial or baronial English. Generally in colonial design the boards are from 4 to 12 inches wide, and of pine, while in English design the wood selected is either oak or teak.

In the early days, these boards were produced by hand, as no machinery was available, and so they were laid as plain boards without the tongue and groove, and were top-nailed in most cases. The modern flooring of this type comes with the tongue and groove, and can be either blind-nailed or top-nailed, or both.

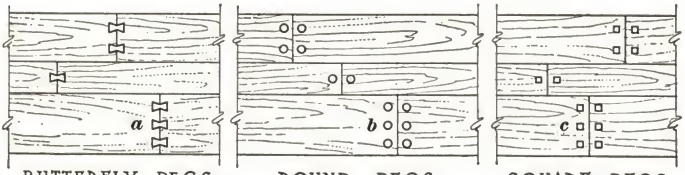


FIG. 19

Plank flooring is generally not less than 1 inch thick, the usual thickness being $1\frac{1}{4}$ inches. The widths are often varied in order to enhance the informal effect. White and yellow pine, oak, teak, and mahogany are the woods most used.

Where the floor is screwed through the top, wood insets, or pegs, are fitted over the nails or screws. This gives an interesting effect and imitates the use of the wooden pegs which were commonly used in the early days of wood flooring. In Fig. 19, pegs known as butterfly pegs are shown at *a*, round pegs at *b*, and square pegs at *c*. Top-nailing is used in addition to the secret nailing along the side which, combined with the tongue and groove, holds the flooring firmly. When the boards are very wide it is necessary to top-nail along the center of the board. Usually these nails are countersunk and the space above them is filled with pegs when finishing the flooring, in order to hide the nails.

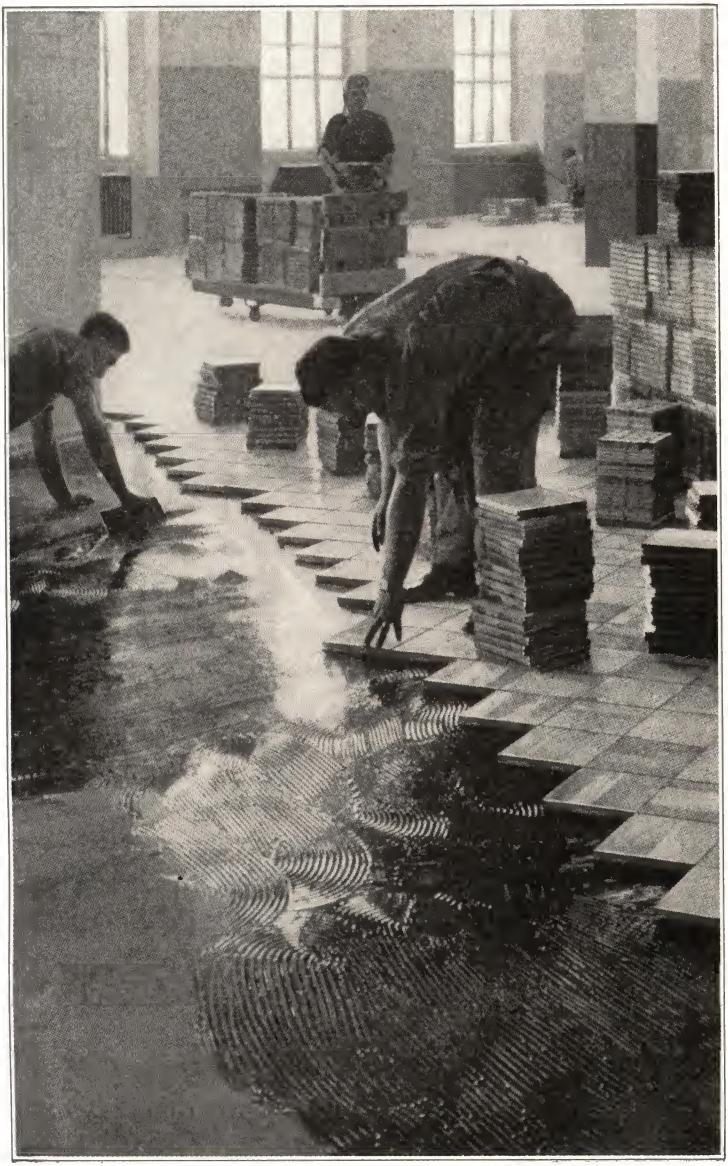


FIG. 20

100. Unit Wood-Block Flooring.—The type of flooring known as unit wood-block flooring is usually finished in the same manner as flooring in fine rooms and is used for the same general purposes.

The blocks, if thick, are made up of strips of tongued-and-grooved flooring glued together or, if thinner, of grooved strips reinforced with splines. The strips are usually from 1 inch to 2 inches wide and from $\frac{3}{32}$ to $\frac{25}{32}$ inch thick. When they are secured together, they are mounted on canvas so that they can be laid in the completed block form. These blocks are about 9 inches square, although they may be made in other sizes to fit special designs. They can be either top-nailed, secret-nailed in the thicker types, or laid in mastic.

Some of these types are sold with the finish already applied at the factory, so that they require only the final coat of wax for completion. In most cases they come only in the hardwoods and can be factory selected for matching of grain and color.

These blocks in the process of being laid in mastic are shown in Fig. 20. While sometimes used in areas which have slight industrial use, this type of flooring is mostly confined to use in living rooms, libraries, reception rooms, etc. to give a parquetry effect.

101. Base Under Wood Flooring.—In any type of wood flooring the base is very important and proper preparation should be made for laying the flooring used. Otherwise squeaking, buckling and other irregularities will result.

102. Laying in Mastic.—Mastic is used when the wood flooring is laid directly over concrete without any wood underfloor or sleepers. The concrete must be thoroughly dry before the wood flooring is laid.

Mastic consists of a thick liquid, generally of an asphaltic nature, and is used either hot or cold, depending on the kind selected. The mastic is spread over the floor and then on the back of the wood strips or blocks, which are set level and tamped into place, being driven together to form close joints.

The mastic does not completely harden and there is always

a high percentage of adhesion both to the concrete and to the wood. As a general thing, only short-strip flooring is used in this method of flooring in finished rooms, although long strips can be laid if required.

103. Scraping and Planing Wood Flooring.—Scraping and planing the wood flooring is done in order to secure a smooth even surface to receive the finish.

Soft woods are generally planed, and the edges against the wall must be scraped where the plane cannot reach. Plane marks should not show if the work has been well done.

For hardwood flooring, the usual methods are to scrape the surface by hand or to sand it with a machine. When scraped by hand, the floor is first wet, and then a flat metal scraper is pulled across, taking off all the roughness and raised grain, until the floor has a fine smooth surface, without tool or other marks.

In the case of large areas, the smoothing is often done by sanding with an electrically operated machine. The sandpaper is mounted on a large roller that revolves as the machine crosses the floor. The sanding is first done diagonally and then in the direction of the length of the flooring parallel to the length of the boards. A coarse sandpaper is first used, followed by a fine sandpaper. Care must be taken to avoid too much pressure at any one point, as otherwise hollows will be created. The resultant surface should be very fine, level, and smooth.

104. Finishing Wood Flooring.—After being prepared by sanding, scraping, or planing, the finishing protective coats are applied. For an inexpensive finish, a stained filler is used to close the grain and give the color, followed by one or two coats of varnish. This finish, while resistant to wear, does show scratches and is difficult to refinish without going down to the bare wood.

WOOD FIBER FLOORING

105. Composition.—The wood fiber type of flooring is generally composed of wood fibers, with magnesite as a binder, compressed under heavy pressure. It makes a soft, resilient floor, susceptible of fairly heavy wear. It usually comes in a number of plain colors with close-grained texture. The surface design mostly used is one resembling travertine, both in color and texture.

106. Sizes and Thickness.—The standard sizes of wood-fiber flooring slabs vary according to each manufacturer's production, but, as the slabs can be cut with a saw in the same manner as wood, the pieces can be arranged to suit almost any pattern. The average thickness is from $\frac{5}{8}$ to $\frac{3}{4}$ inch.

107. Laying.—A space of about $\frac{1}{8}$ inch should be allowed for this material when placed on a concrete or wood underflooring. As a usual thing, it is laid in a waterproof compound, similar to a mastic, developed by each manufacturer for his own product. Over wood it can be nailed into position, the nails set below the surface level, and the nail holes filled with a compound to match the material. The joints are filled, after laying, with a mastic non-staining compound resembling mortar.

108. Finishing.—Wood fiber block flooring is usually thoroughly cleaned after laying by washing, without using too much water. Sanding should not be done, as this will destroy the surface texture. The floor is finally given two coats of a good floor wax, usually in paste form, well brushed in.

109. Uses.—Wood-fiber flooring makes an excellent quiet flooring for use in formal living rooms, halls, libraries, etc. It has a certain noise-reduction value which also makes it desirable in institutions where quiet is desired. The pattern is entirely a matter of design.

RESILIENT FLOORING

CHARACTERISTICS

110. Description.—The term *resilient flooring* is applied to those products in which the basic composition is a resilient material, such as cork, asphalt, or rubber. These materials are combined with binding cements and are produced by any of several methods.

The most useful qualities of these floorings are cleanliness and comfort. The resilience and quietness varies with the thickness, the top surface, and the base on which the surface is applied. Generally speaking, these materials are not resistant to acids, but grease, dirt, and ordinary stains can be readily cleaned off without damage to the surface.

Resilient floors are generally thin, and for that reason are laid after all construction work has been finished. They are particularly adaptable for use over old flooring in existing buildings. They are readily applied, but skill is required in fitting the material into the spaces. The base on which they are laid must be firm and level, as irregularities will show through the thin material. The adhesive material used for attaching the flooring to the base must be of a kind that will adhere firmly to both the material and the base.

111. Uses.—While the first general use of resilient flooring was in kitchens and bathrooms, where sanitation and ease of cleaning were definite requirements, today their use has spread to almost every kind of room. It is only where there is heavy trucking, acids, or excessive dampness that they will not stand up. Recent developments which have improved the quality of workmanship now make this material available for many spaces where a quiet floor with resilient qualities is desirable.

112. Colors.—Originally manufactured in plain colors, and with designs printed only on the surface, resilient flooring is now almost universally produced with the colors extending entirely through the material. Color variations, marble and tile, and other special effects can now be secured.

LINOLEUM

113. General.—Linoleums are perhaps the most commonly used of all floor coverings of the resilient type. They are made in a number of different kinds, each kind produced in a number of thicknesses or gages, and have been stand-

TABLE VI

TABLE OF GAGES OF LINOLEUMS

Material	Approximate Thickness Inch	Finished Gage Inch
Linoleums		
Plain		
6mm. (Battleship)	$\frac{1}{4}$	.236
$\frac{3}{16}$-inch (Battleship)	$\frac{3}{16}$	.188
Heavy (Battleship)	$\frac{1}{8}$	.125
Medium (Plain)	$\frac{3}{32}$	.095
Standard (Plain)	$\frac{5}{64}$	.075
Jaspe		
$\frac{3}{16}$-inch	$\frac{3}{16}$	.188
Heavy	$\frac{1}{8}$	.125
Medium	$\frac{3}{32}$	.095
Hand-made marble inlaid		
Heavy	$\frac{1}{8}$	.125
Medium	$\frac{3}{32}$	.095
Standard	$\frac{5}{64}$	.075
Straight-line inlaid		
Heavy	$\frac{1}{8}$	.125
Medium	$\frac{3}{32}$	.095
Standard	$\frac{5}{64}$	.075
Embossed inlaid		
Heavy	$\frac{1}{8}$	.125
Medium	$\frac{3}{32}$	.095
Standard	$\frac{5}{64}$	.075
Linoleum tile	$\frac{1}{8}$	.125
Cork carpet	$\frac{1}{4}$	.312

ardized by both the Government and the Industry Association as shown in Table VI.

114. Composition.—All linoleums are composed of cork ground into powdered form, mixed with an oxidized linseed oil, and applied to a backing. The backing is usually of burlap, but asphalted felt is used in the less expensive types. This mixture is compressed under rollers and then placed in an oven, where it is baked or matured until oxidation is complete.

The U. S. Government has developed standard requirements for resiliency, resistance to indentation, pliability, water absorption, and strength of keying to the backing. These requirements are generally followed by all manufacturers, and the major differences between the products of different manufacturers are found in the color and texture effects and in the quality of materials used.

115. Kinds of Linoleum.—The word linoleum should never be used by itself in describing this material, as it is applied correctly only to the thin gages of plain linoleum. Each of the various kinds has its own name, which should be used in describing it, together with the proper gage. The kinds most commonly produced are battleship linoleum, plain linoleum, jaspe linoleum, marbleized linoleum, straight-line inlaid linoleum, embossed linoleum, printed inlaid linoleum, linoleum tile, and cork carpet.

116. Battleship Linoleum.—Battleship linoleum is so called because it was first produced in large quantities to meet U. S. Navy specifications for warship flooring. It includes only the thickest three of the five linoleum gages which are produced in plain colors. These thicknesses, as shown in Table VI, are $\frac{1}{4}$, $\frac{3}{16}$, and $\frac{1}{8}$ inch. It is made in rolls of varying width, generally 6 feet, and is laid in strips as wide as possible, except where joints are required for design. It is sometimes cut into small blocks and used in tile patterns, but this must not be confused with the true linoleum tile later described.

Battleship linoleum is especially useful where there is unusual wear, as in school corridors, laboratories, offices, ship decks, and light manufacturing buildings. It may also be used in

kitchens, bathrooms, and living rooms in dwellings, where linoleums are much used.

Battleship linoleum is often made in special designs, as with borders and stripes, as shown in Fig. 21.

117. Plain Linoleum.—Plain linoleum is of the same composition as battleship linoleum, but is thinner, as indicated in Table VI. In general, its use is the same as battleship linoleum, except that it will not withstand the heavy uses for which the

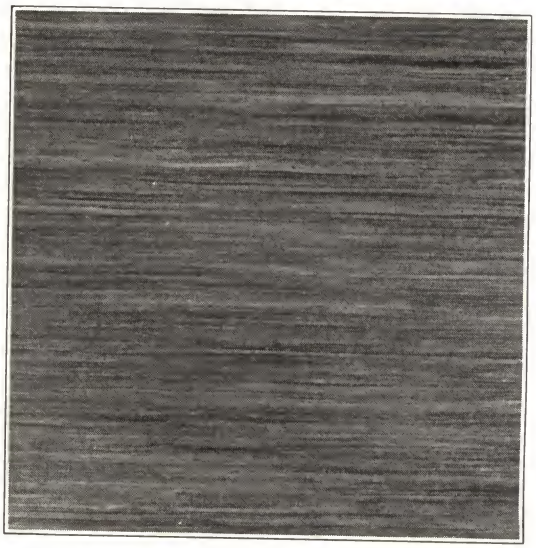


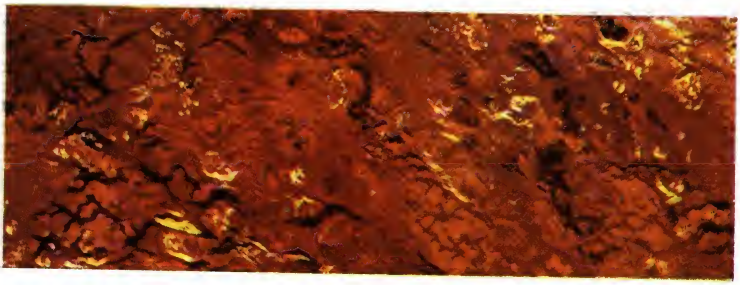
FIG. 22

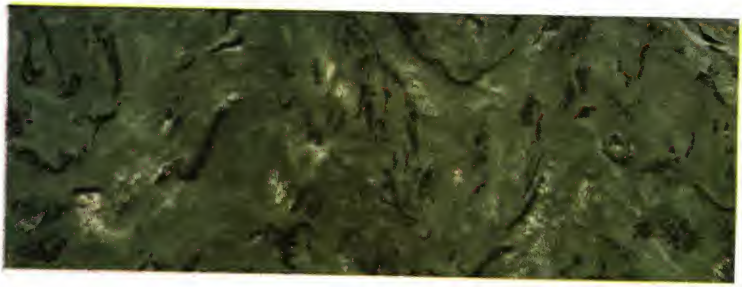
thicker gages are adaptable. It requires also a more even base, as any slight unevenness in the base will show through the linoleum.

118. Jaspe Linoleum.—Jaspe linoleum is of the same composition as the battleship linoleum but, because of the streaked or striated color effects, is given the name jaspe. An example of jaspe linoleum is shown in Fig. 22. The striations and irregularities are now made in various color combinations.

The surface effect of jaspe linoleum was developed as a means of producing a linoleum flooring in which discoloration

Serial 5375 FIG. 21 *Courtesy Armstrong Cork Products Co.*





Serial 5375

FIG. 23

Courtesy Armstrong Cork Products Co.

Serial 5375 FIG. 24 *Courtesy Armstrong Cork Products Co.*

Serial 5375 FIG. 25 *Courtesy Armstrong Cork Products Co.*

caused by dirt, slight irregularities in laying, and the monotony of a single tone would not be noticeable. Likewise, any part subject to constant wear would not be so likely to show as plainly as on a single color. Jaspe linoleum is much used in plain colors, with plain borders, in which it is very effective.

119. Marbleized Linoleum.—Marbleized linoleum is the same composition as battleship linoleum and jaspe linoleum, and is so called because the colors reproduce the distinctive veinings and effects of marble. This linoleum is extremely colorful and shows excellent imitations of marble, being hard to distinguish, except by feel and wear, from the stone itself. Four of these effects are illustrated in Fig. 23.

120. Straight-Line Inlaid Linoleum.—In straight-line inlaid linoleum the design on the surface is carried entirely through the material, so that, no matter how much worn, it still carries the same color and effect. These linoleums are made in many designs, especially in the reproduction of tile flooring. They are made in roll width, which can be cut to fit any space.

121. Embossed Linoleum.—Embossed linoleum has the same composition and arrangement as straight-line inlaid linoleum, the difference being that the joints between the design units are actually depressed, making the tiles or blocks stand out in relief. Embossed linoleum is made in rolls, like the other linoleums. They produce the effect of a continuous floor with few seams, while giving the appearance of individually laid tile.

Owing to its interesting effects, this type of linoleum flooring is much used in cafeterias, cafes, dens, where colorful tile floors are desired, but where it is not possible to install the clay tile. An illustration of embossed linoleum flooring is shown in Fig. 24.

122. Printed Inlaid Linoleums.—Printed inlaid linoleum flooring is produced only in the very thin gages. It is backed with asphalt-impregnated felt, and the design is printed on the surface only. It is used where economy in first cost is an

important factor. This is also the type and composition used in the production of linoleum rugs.

123. Linoleum Tile.—Linoleum tile consists of separately made tiles, having the same composition as other forms of linoleum flooring. In individual tiles, the resultant body and surface are harder than those of the roll types of linoleums, and more resistant to heavier usage. They can also be better adjusted to any irregularities in the floor and, if repairs are required, it is a simple matter to take out the number required and to replace them.

The colors and surface effects of these tiles may be plain, jaspe, or marbleized. Their thicknesses are given in Table VI and their sizes in the accompanying tabulation.

Linoleum tile can be laid in numerous patterns in which different sizes of tiles are combined, or the tiles may be combined with plain strip borders to create effects. Linoleum tile is very serviceable, especially in large kitchens, wash rooms, halls, corridors, vestibules, and lobbies.

SIZES OF LINOLEUM TILE

Squares:

2″, 3″, 4″, 6″, 8″, 9″, 12″, 18″, and 36″

Oblongs:

3″ × 6″	3″ × 12″	4″ × 16″	6″ × 12″
9″ × 18″	18″ × 36″	24″ × 36″	30″ × 36″

124. Cork Carpet.—Cork carpet is of the same composition as battleship linoleum and is produced in the same manner. It comes in rolls like plain linoleum. Only two colors are available, brown and green.

Cork carpet is a soft, noise-absorbing floor covering and is much used in such spaces as drafting rooms, libraries, music rooms, churches, etc., where quiet and sound absorption are both desirable. It absorbs shock also and makes an excellent floor in spaces where there are many machines such as typewriters and accounting machines. It should not be used where there is a possibility of either water or grease being present, as, owing to its porous surface, it is easily stained.

CORK FLOORING

125. Description.—Cork flooring is made of pure cork compressed under heavy pressure, and without any backing. It is obtainable in rolls, but it is generally produced as separate tiles, of the sizes shown in the accompanying list, $\frac{1}{2}$ and $\frac{5}{8}$ inch thick. Generally the edges are straight, but certain types can be secured with beveled edges. The colors are varying shades of natural cork, from light to a dark brown. Being laid in individual pieces permits the material to be effectively treated by the use of designs embodying the various color shades.

SIZES OF CORK TILES

Squares:

2″, 3″, 4″, 6″, 9″, 12″

Oblongs:

2″ × 6″	3″ × 36″	6″ × 18″	12″ × 18″
2″ × 9″	4″ × 12″	6″ × 36″	12″ × 24″
3″ × 9″	6″ × 9″	9″ × 18″	12″ × 36″
3″ × 12″	6″ × 12″	9″ × 36″	

Cork flooring is resistant to all but the strongest greases and, owing to its close texture, can be readily washed.

This type of flooring is very resilient under heavy traffic except trucking, and can be used in spaces where people congregate. Corridors, assembly rooms, libraries, churches, restaurants, lobbies, and simliar rooms are excellent places for its use.

Cork flooring is not for exterior use, nor should it be used in entrance vestibules where there may be sand and grit, as these would spoil the surface. The degree of hardness varies, however, so that for unusual conditions, as under heavy tables in libraries, the harder types can be used to avoid indentations caused by the pointed legs of the tables.

Cork flooring is easy to repair, as one or more tiles can be removed and replaced without spoiling the floor. Waxing after completion will increase the life of cork flooring, and will bring out the full beauty of the natural cork color.

LAYING LINOLEUM AND CORK FLOORINGS

126. Nearly all of the resilient floor coverings are laid in the same general manner, differing somewhat in the cases of the roll form and individual tiles. In all cases the subfloors on which they are laid must be carefully prepared.

Where these floor coverings are to be laid on wood flooring, the boards should not be over 3 inches wide, and they should be tongued and grooved and thoroughly nailed. The wood joints should be planed, so that there will be no projections, and the entire base should be level. When laid on concrete, the base is prepared by a top coat of cement and sand, as described under Cement Floors, or by placing a topping on the slab, which should be screened and troweled to a level surface by means of a darby float.

Except over thoroughly dry cement floors or similar non-absorbent surfaces, a layer of lining felt should be first applied. This acts as a base and cushion to receive the linoleum or cork. The lining felt is laid in a specially prepared linoleum paste, rolled flat with a heavy roller, and allowed to dry.

Before the linoleum or cork is laid, the floor should be thoroughly tested to make sure that it is dry. Concrete floors are generally tested by placing calcium chloride on the floor and tightly covering it with a glass dish. If the calcium chloride dissolves, the floor is still too wet to receive the linoleum.

Linoleum is laid in the same kind of paste that is used for the lining. As soon as the linoleum is placed it is rolled with a heavy roller, weighing about 150 pounds. The seams are weighted with sand bags until the paste has thoroughly set, not less than 12 hours being allowed. The bags are then removed and the floor washed with a good non-alkaline floor cleaner. Finally, the floor should be given two coats of prepared floor wax in liquid form, either brushed or rubbed in.

In some cases the linoleum is furnished with the wax finish applied at the factory. Greater penetration and additional protection are thus secured. When this is the case, the floor

need only be cleaned after installation, although it is usual to touch up any rubbed spots and apply one coat of wax after all other work in the building is completed.

When cork tile is used, it is sometimes lightly sanded to level the joints, but only where required. It is then cleaned and given the same wax finish as the linoleum.

RUBBER FLOORING

127. General.—Rubber floor covering is made in three general forms, known as interlocking rubber tile, sheet rubber, and rubber tile. They are composed of rubber of varying degrees of hardness for special purposes, but are noiseless and have a high resiliency. In most cases they are solid rubber of the same composition throughout, but some kinds have a surface of a harder rubber, which is vulcanized to a softer rubber back in order to increase the resiliency.

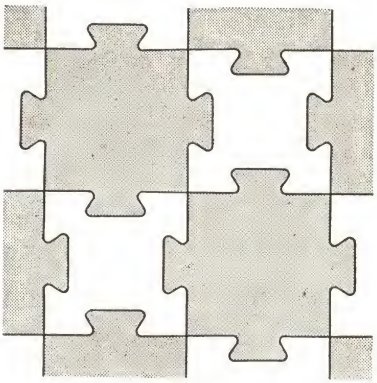


FIG. 26

128. Interlocking Rubber Tile.—Interlocking rubber tile is the hardest form in which these tiles are made, and is used where there is very heavy wear, such as in elevator cabs and where there is a great deal of water and grease. This form of tile resists injury by almost anything but strong acids.

Interlocking tiles are shown in Fig. 26. They make a compact floor in which the joints are so close as to be practically non-existent. They are made generally $\frac{5}{8}$ inch thick, the shape

and size varying with different manufacturers. This type of tile forms a floor that is a good insulator against high-voltage electric transmission, and is much used in transformer and battery rooms.

129. Sheet Rubber.—Sheet rubber is of rubber composition, generally reinforced with a woven cotton fabric which may be vulcanized in the material or secured on the bottom surface. It is made usually in $\frac{1}{8}$- and $\frac{3}{16}$-inch thicknesses and in rolls of varying widths.

Sheet rubber is used almost entirely where the peculiar qualities of rubber, such as insulation against electric current and resistance to grease and water, are desirable, and where appearance is not a consideration. This makes it useful for such places as steel-plate floors around switchboards, in transformer rooms, and around mechanical equipment.

Sheet rubber is also produced in marbleized and two-tone effects, for cases in which a floor of this type having surface decoration is desired. Plain colors form, however, the bulk of the production.

130. Rubber Tile.—Rubber tile is the most commonly used form of rubber floor covering. It is either produced in individual molds or cut into sizes from large sheets. The tiles are of straight rubber composition, and generally are reinforced like sheet rubber. The colors and effects extend through to the back, except in the kinds that are mounted on a special sponge-rubber backing. In Fig. 25 is shown an example of rubber-tile floor covering.

Colors are secured in rubber tile by the addition of mineral pigments to the rubber. The tiles are made in many plain colors and also in marbleized and two or more toned effects. The variety of choice in color is almost as extensive as in linoleum.

The usual thickness of rubber tile is $\frac{1}{8}''$, $\frac{3}{16}''$, or $\frac{1}{4}''$, although tile in $\frac{3}{8}''$ and $\frac{1}{2}''$ thicknesses can be obtained for use in cases where the heaviest type of wear occurs. The tiles are usually in dimensions of 2″, 4″, 6″, 9″, 12″ and 16″ square. They are also made oblong in form.

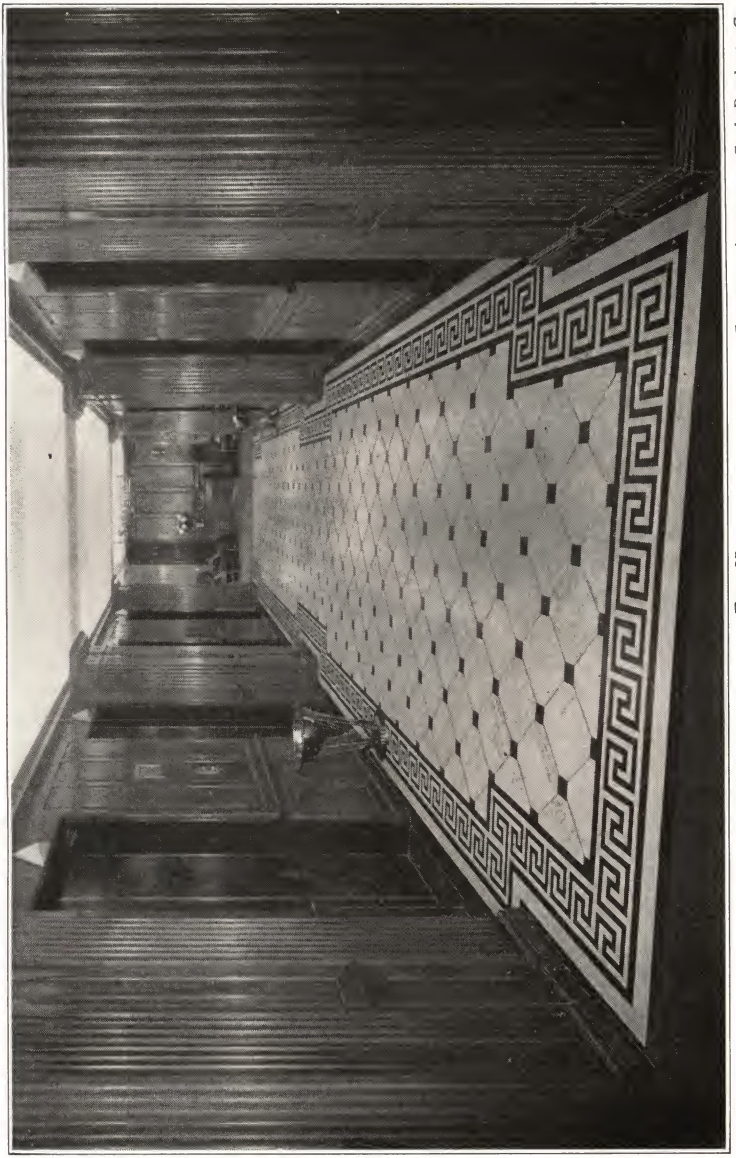


FIG. 27 *Courtesy Armstrong Cork Products Co.*

Because of its resistance to ordinary stains, such as ink and grease, rubber tile is particularly adaptable to use in banks, stores, offices, reception rooms in large buildings, etc.

131. Laying Rubber Flooring.—The method of laying rubber flooring is the same as that used in laying linoleum, and the same care should be taken in the preparation of the base. Felt linings should be used on wood floors, but can be omitted on a non-absorptive type of base. The lining when used is laid in a linoleum paste and rolled flat.

Rubber flooring is laid in a specially prepared rubber cement, which is spread on the floor lining. Where dampness is present, a waterproof type of cement should be used. This form of cement, which has greater adhesive qualities than the regular cement, should be used for such places as stair treads, on coves, or on thresholds.

The cement should be applied very thinly, as the rubber is not absorptive, and any excess cement may form into balls or rolls when the floor is rolled after laying. The rolling should be done with a heavy roller as in linoleum laying, and should be continued for at least 15 minutes. This forces the tile into the cement, removes all air bubbles, and leaves the floor absolutely level and in uniform contact with the base.

132. Finishing Rubber Flooring.—The finished flooring should not be touched for at least 5 days after it is laid and rolled, so that the cement will have an opportunity to dry thoroughly. The flooring should then be washed carefully with a prepared solution and again be allowed to dry. A wax polish is next applied, allowed to dry on the surface, and thoroughly buffed or rubbed. If no polish is required on the kind of flooring used, it should be rubbed or buffed to restore the natural sheen of the material.

133. Designs in Rubber Tile.—The possibilities in the use of rubber tile are the same as for linoleum tile, including the use of a field of tile with borders in strips of the sheet rubber, as shown in Fig. 27. In order to avoid complications in laying, it is necessary to use the same thickness of material

throughout. Interesting treatments can be developed, such as figures cut in the floor to form titles, seals, etc.

134. Special Shapes.—In rubber flooring, as in linoleum, many shapes are made for special purposes. These include coves for use at the junction of floor and wall, inside round corners, high bases with cove at the bottom, shaped thresholds and sills, etc. These are used where the complete floor is to be carried out in the same material. Complete sanitation and protection with this composition is thus made possible.

ASPHALT TILE

135. Composition.—Asphalt tile is a type of resilient flooring especially developed for use on concrete at grade level or where there may be slight dampness, although, in its more finished and colorful forms, it has come into general use wherever resilient floorings are used.

Asphalt tile is composed of inert materials such as a natural asphalt binder and mineral pigments, the latter providing the color. In some cases a rubber compound is used as a part binder. The materials are mixed thoroughly under heat and compressed under heavy pressure.

136. Hardness.—The degree of hardness of asphalt tiles varies, and is generally determined both by the expected use and the condition of the base. When laid over an old floor, which may not be uniformly level, a somewhat softer tile is desirable. The manufacturers' recommendation should generally be followed in this matter, as their experience has shown what is the best type for each condition.

137. Thickness.—The standard specifications, adopted by the Government and accepted by the Industry, provide for thicknesses of $\frac{1}{8}$, $\frac{3}{16}$ and $\frac{1}{4}$ inch, although $\frac{3}{8}$ and $\frac{1}{2}$ inch are also available, but in fewer colors and effects than in the thinner kinds.

138. Colors and Surfaces.—There is a considerable range of colors from which to select, including many of the marbleized effects used in linoleum and rubber tile. In asphalt tile

the color extends solidly through the thickness of the material. Examples of colors are given in Fig. 28.

139. Uses.—Asphalt tile is fire-resistive, will withstand the action of mild acids and alkalis, and is not affected by dampness. It is an excellent material for use in basement rooms, as there is nothing in its composition which encourages rotting or deterioration.

This tile is also resistant to heavy wear and tear. For that reason basement playrooms, school classrooms, corridors, and lobbies are good places for its use. It forms excellent insulation against electric currents and is used in switchboard and transformer rooms and in power houses, where there may be constant traffic and light industrial trucking.

140. Laying Asphalt Tile.—In laying asphalt tile at grade level or below, over concrete, and over wood underflooring, a layer of asphalt sheeting or an asphaltum under coating should first be placed. The sheeting should be laid with an asphalt cement, an asphalt primer being applied on the concrete before the sheet is laid. This provides protection from dampness from below in the case of concrete and forms a continuous level base in all cases.

On thoroughly dry concrete above grade and on steel floors, where there is no likelihood of later dampness, this protective layer may be omitted.

In laying the tiles, they are first heated with a blow torch until they are pliable, and are then set in a prepared asphaltic cement which has been spread on the floor. The tiles are carefully set with even joints and pushed or bent as necessary to adjust them to the base. The entire floor is then rolled with a heavy roller weighing not less than 150 pounds.

When the cement has thoroughly set and dried, the tile can be washed, care being taken not to use a solution containing naphtha or turpentine, as either one acts as a solvent for the asphalt composition of the material. For a final finish the floor should be given at least one coat of wax and buffed or rubbed.

Serial 5375 FIG. 28 *Courtesy Armstrong Cork Products Co.*

141. Jointing.—Asphalt tiles are always laid with a close joint, requiring no filler other than the amount of material squeezed from the layer on the floor when the tiles are rolled. This rolling and the subsequent wear cause the tiles to adhere at the joints, making a homogeneous floor. If the joints are too wide, the tiles will spread and the floor will not remain level.

MASTIC FLOORING

142. Nature.—Mastic flooring is a flooring that is applied while in a plastic state over a prepared base. It is then leveled, troweled, and surfaced with a float, or by rubbing until it is smooth and even.

143. Composition.—The basic composition of each kind of mastic flooring varies according to formulas developed by different manufacturers. The basis may be of wood fibre, cork shavings, asphalt, magnesite, cement, gypsum, or similar materials that lend themselves to mixing in a form which will harden into a finished floor covering. Color pigments of various kinds are used and are usually added in the mix at the factory when produced. In some types of mastic flooring, the color can be added at the building when the flooring is laid.

Certain types of mastic flooring are produced for industrial purposes and are usually laid in a thicker layer than the kinds used for residential rooms. When sufficiently thick the resistance to wear may be increased by the addition of sand or small-sized aggregates.

144. Color.—Most of the types made, especially those for use in finished rooms, are available in many colors. The heavy industrial types are usually restricted to a few basic neutral tones. Mastic flooring can also be laid in combinations of colors, by laying each color separately to avoid running together, or by using metal dividing strips as in terrazzo work.

145. Advantages.—The advantage claimed for mastic flooring is in its flexibility, especially where it is required to

adjust a finished floor to irregularities in the under floor or base. This can be readily done in mastic flooring, as the material is plastic and will fill any hollows. Care should be taken that at no point is the thickness reduced to less than that recommended by the manufacturer. Any projection above the general level of the base may cause a crack after the flooring has dried.

146. Hardness.—Mastic floorings vary from types that have soft surfaces and will not resist much hard usage, to types which are sufficiently hard to withstand heavy industrial trucking. They can be made as hard as stone or cement by the addition of abrasives. Some types are available for noise reduction only. Selection should be made only after careful consideration of the eventual use of the floor.

147. Laying Mastic Flooring.—Most types of mastic flooring are delivered to the building in dry powdered form. They are mixed with the proper proportions of water, thoroughly mixed in batches, and then spread on the floor. In some cases the mixture is applied in two coats, in which case the final color is incorporated only in the top coat, which should be at least $\frac{1}{4}$ inch thick.

When the base is of asphalt, it is sometimes applied after heating at the building, but asphalt materials can be secured which are applied cold. The thickness of the finished flooring varies according to the type and use. None is less than $\frac{1}{2}$ inch thick, and this minimum thickness is used only when the flooring is laid over a substantial, level, concrete base. The types generally used are $\frac{3}{4}$ inch or more in thickness.

If a wood floor forms the base on which the mastic is to be laid, the wood must be thoroughly top-nailed as well as blind-nailed. Some manufacturers advocate nailing a wire-mesh reinforcing to the wood floor before any mastic is applied. This reinforcing acts as a shrinkage preventive and holds the finished flooring firmly to the base. When laid on a concrete or similar dense floor, reinforcing is not necessary, but the concrete should be free from any projecting aggre-

gates and be troweled or floated to a smooth, level surface. In any case the manufacturer's recommendation for each type of floor selected should be carefully followed.

FIG. 29

RUGS AND CARPETS

148. Rugs.—Rugs in attractive colors and patterns are familiar forms of floor coverings, especially for living rooms, as illustrated in Figs. 29, 30, and 31. They are sold in stock sizes to fit rooms of standard dimensions. For extra-large

rooms, two or more rugs can be used, or rugs of the proper size can be made to order. Many rugs are made in oriental patterns, as shown in Fig. 29. As shown in Fig. 30, individual

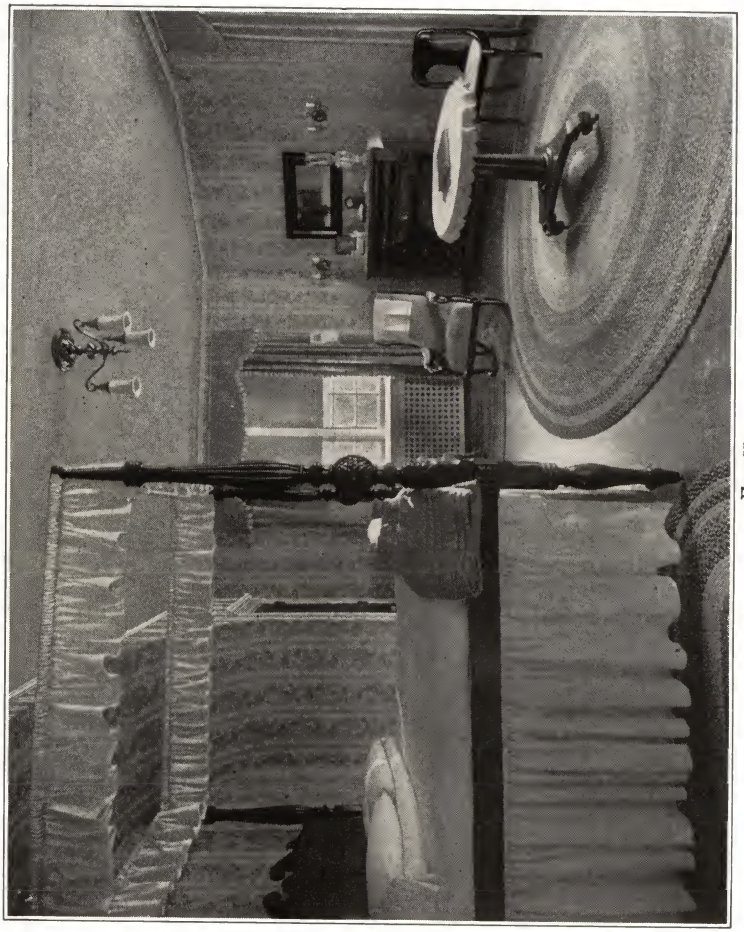


FIG. 30

rugs of small size are used, especially in bedrooms. The rug in Fig. 31 is of modern renaissance design.

149. Carpets.—Floors are sometimes covered over the entire surface with carpet, as shown in Fig. 32, generally of

a neutral shade, such as taupe. This makes a very quiet and useful floor in living rooms. Carpets should be laid over a

FIG. 31

layer of heavy prepared paper. On wood floors they are sometimes fastened to the floor with tacks, but heavy carpets will stay in place, as their own weight will hold them.

WALL COVERINGS

PLASTERING

150. General.—The most common wall construction to which the wall coverings are attached, are of masonry, plas-

FIG. 32

ter, and wood. Only some of the more unusual plaster surfaces or coverings attached to such wall constructions will be described here.

151. Stone Effects.—Plaster is sometimes used in producing effects imitating the surfaces and colorings of natural stones. It is applied by either of two methods.

One method is by using as a base, two coats of a cement plaster, made of either Keene's cement or non-staining portland cement. On this base a finishing coat is applied in the same manner as the usual final plaster coat, and the surface is troweled to secure the desired texture. The final coat is usually composed of the material to be imitated, ground fine and mixed with white portland cement. When the surfaces are to be jointed, the joints are generally cut in after the coat is dry and are filled with cement as in real stone work.

In the other method, the plaster is cast in molds, forming separate slabs, and the slabs are laid up in the same manner as natural stone, by using mortar, tying it into the wall, and filling and pointing the joints.

152. Caen Stone Plaster Surface.—One of the most usual finishes of this type is Caen stone plaster. Caen stone, a natural stone found in France, ground to a powder, is the base for this finish, and it gives the plaster the proper color and texture when combined with the sand and cement. When the surface is dry, it is sandpapered smooth to represent a sand-rubbed surface, or combed with a tool to resemble a tooled surface. Joints are usually cut in the finishing coat and are filled with white mortar, producing an effect similar to that shown in Fig. 29.

Generally no protective material is applied after the surface texture has been applied, but it has been found desirable to brush on a colorless binder to prevent the fine sand from rubbing off. Such a binder may be a thin skim milk or a very weak tea or coffee solution. Before applying this binder it is well to experiment first on a separate piece of surface to observe the effect.

153. Limestone and Granite Surfaces.—The method used in imitating Caen stone is used in imitating limestone and granite colors and textures. The finished plaster in such cases should have a cement rather than a lime base, and is applied

like plaster. The wall in Fig. 29 also illustrates a treatment in limestone, or granite plaster with a cast mantel facing.

154. Scagliola.—Scagliola is the name given to imitation marbles made on a plaster base. It is made either by casting in molds or by applying it at the building like plaster.

Scagliola is composed largely of a white non-staining cement, sand, and finely ground marble or mineral pigments of the colors desired. When the material has been finished and is thoroughly dry, it is buffed to secure a polished surface.

Scagliola, when cast separately, is set in the same manner as marble, but, because of its greater fragility, care must be exercised to avoid chipping. It must also be carefully protected against dampness and the possibility of staining.

Almost any kind of marble can be imitated in scagliola, and it is, therefore, much used where the natural stone might be prohibitive in cost. The lightness of the material makes it usable where the construction does not permit the use of the heavier natural marbles.

155. Acoustical Plaster.—Acoustical plaster is a composition in which noise resistance or sound absorption is secured by mixing wood chips, fiber, asbestos, etc., with gypsum or lime plaster. It has a loose, open texture when applied on the wall, in which the pores and open spaces absorb the sound and prevent its reflection.

Acoustical plaster is generally applied as the two finishing coats over a scratch coat of ordinary plaster. It is troweled to a level surface, but care is taken not to destroy the texture. In cast form this material is known as acoustical tile, and is further described under sound deadening.

WALL PAPERS

156. General.—Wall papers are produced in standard-sized rolls, 18 inches wide, in various colored designs. Plain papers with stippled effects, known as ingrained, or cartridge, papers, generally come in rolls 30 inches wide, while other types come in rolls 22 inches wide, as do the imported papers.

157. Use.—Wall paper may be used for the full height of the wall from the top of the base to the ceiling, as shown in Fig. 30, or it may be used only above the chair rail, as illustrated in Fig. 33. It is much used for the ceilings of rooms, even though other materials may be used on the walls. Wall paper fits into any type of room, and its warmth and texture make it especially desirable for all kinds of living spaces, and for bedrooms, as shown in Fig. 30.

FIG. 33

158. Selection.—Wall papers can be had in the very simplest, plain colors or in elaborate landscape scenes, as in Fig. 33. Some designs represent wood paneling, and in some cases even the shadows are printed, in order to simulate depth, as shown in Fig. 34.

Amusing results can be secured by using animal and

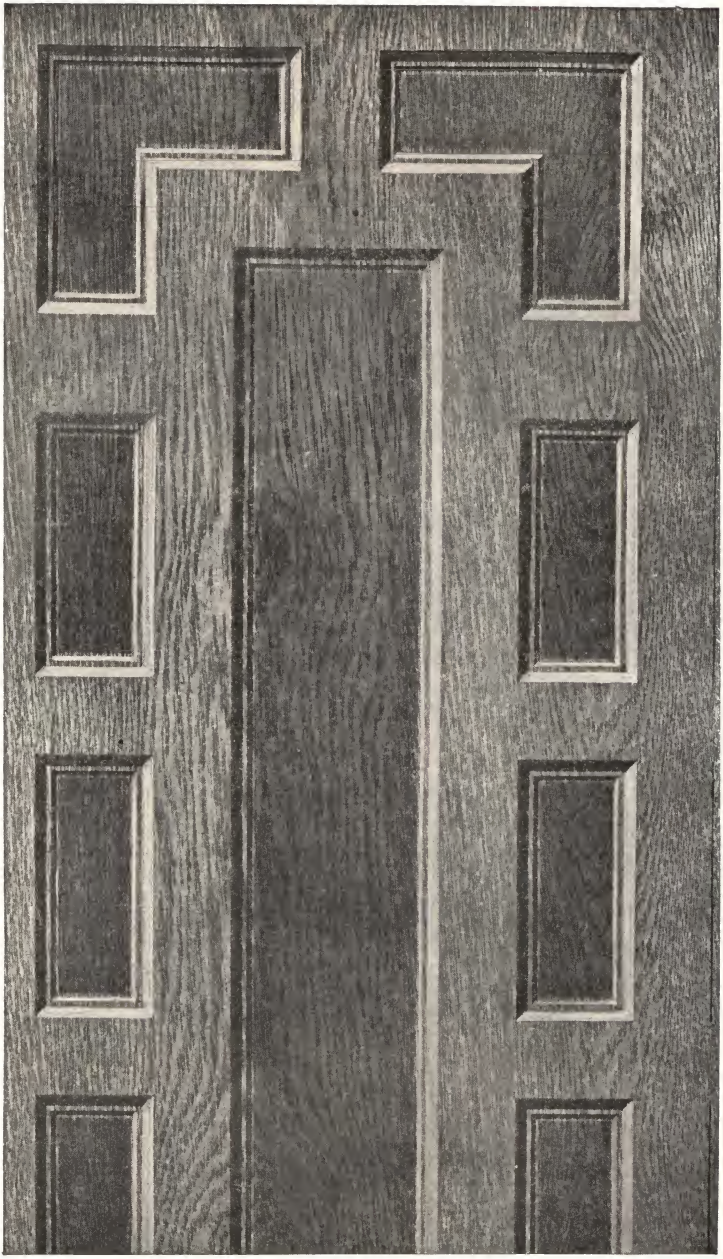


FIG. 34

grotesque patterns, especially developed for use in nurseries and playrooms. Costly hand-painted effects can be secured, including reproductions of paintings, landscapes and pastoral scenes, groups of people, etc.

159. Application.—Wall paper should be applied only on a smooth surface, such as plaster. Wallboard is sometimes used as the base, but the joints and heads of nails must be carefully covered or pointed in order to prevent them from showing through the paper.

The plaster wall surface, or backing, must be dry and thoroughly sandpapered before the wall paper is applied. A coat of varnish size is then applied in order to fill the pores of the plaster and to give better adhesion to the paste that holds the paper.

Paste is applied to the back of the paper and the paper is spread on the wall and flattened into place with a wide brush, and the joints are rolled to make them tight. In papers showing continuous designs, the edges must be carefully matched so that the designs will be continuous.

160. Papers With Special Surfaces.—A recent development in wall papers is a type which has a glazed surface that makes it resistant to dampness. This type of paper is especially serviceable in bathrooms, kitchens, and similar places where moisture exists. It can be cleaned with a damp cloth without damaging it.

Some types of paper can be overstained to secure an antique effect. Overstaining is done after the papers are thoroughly dry, by using either a clear stain, well-thinned, or shellac and applying it to the paper. This finish, in addition to producing an interesting effect, makes the paper more resistant to wear.

WALL FABRICS

161. Kinds of Materials.—Wall fabrics, in general, consist of materials with a woven base and include such fine materials as silk, damask, tapestry, leather, linen or cotter cloth, or very thin wood veneer glued to a fabric base, applied

in the same manner as wall papers. They are produced in many different ways.

162. Leather.—Leather is a particularly serviceable material and is used in libraries, dens, playrooms, etc., especially when a heavy or masculine effect is desired. Leather generally comes in tones of brown, red, blue, and black, but can also be secured in light tones, such as grey or white. Being a heavy material it exerts a very strong pull on the wall, and the plaster or backing must be free of any loose places. A panel of treated leather, Fig. 35, shows the natural markings of the material and the soft colors that can be obtained.

163. Silks and Satins.—Silks and satins are used only when especially elegant effects are desired, as in period rooms showing French influence. They are applied mostly in panels, between wood or plaster stiles and rails. As they are very delicate materials they should be mounted on a stretcher frame before being placed on the wall, so that they will not come in direct contact with the plaster.

164. Tapestries.—Tapestries are either machine-woven in continuous designs or in separate hand-woven panels. Inasmuch as they are normally rather heavy in design and belong to definite periods, they are mostly used only in cases of special design, as in the room illustrated in Fig. 31.

165. Pictures.—Pictures, both in oil and water colors, are used in the same manner as tapestries, although the great range in media in painting makes the selection possibilities greater. Pictures look especially well when built into wall panels as in Fig. 36. They are generally mounted on stretcher frames before being placed against the wall.

166. Wood Veneer.—Wood-veneer wall covering consists of very thin sheets of natural wood cemented under pressure to a backing of linen or cotton. This sheet is applied to the wall in the same manner as wall paper. It shows all of the grain and color effect of the wood from which the veneer is made and is especially desirable where there is not space to use regular wood paneling. Panels can be formed, but, owing to the thin-

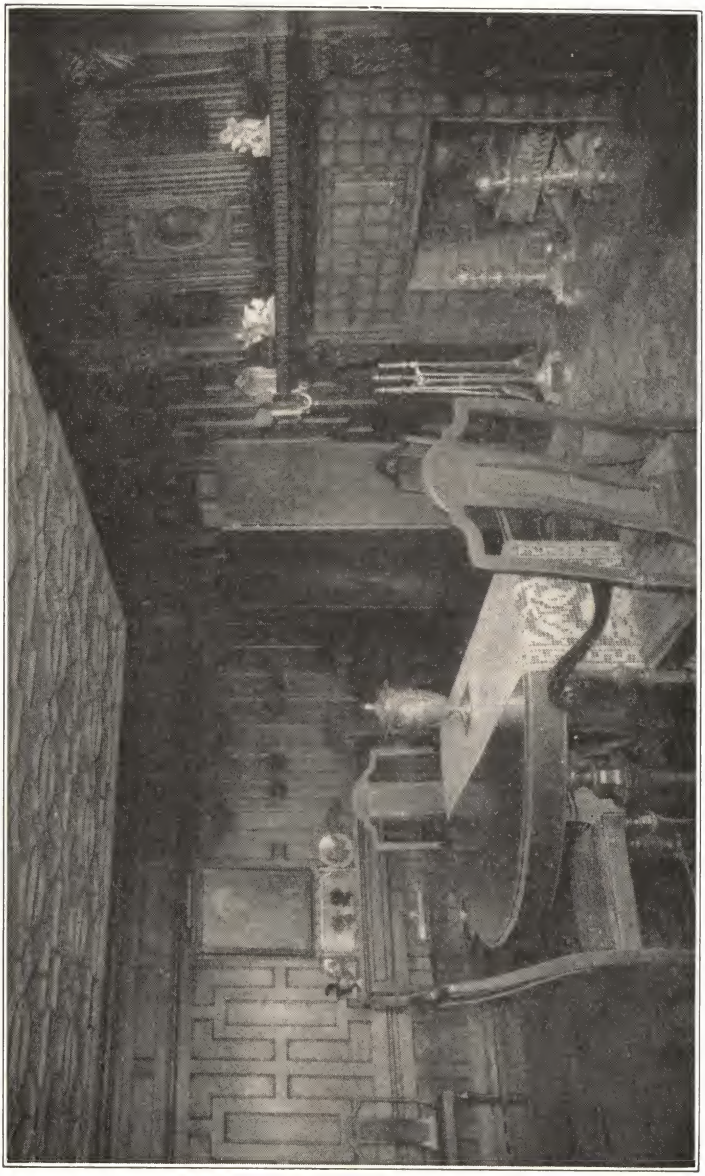


Fig. 37

ness of the veneer, no projection is possible to form stiles and rails. In some cases wood molds are applied on the veneer surface to form stiles and rails.

This fabric is especially suitable for executing designs in the modern manner, in which the walls are covered with continuous wood graining without being divided into panels.

167. Canvas.—In addition to the fabrics that present finished surfaces, there are fabrics which are used primarily as a base for painting. Canvas is a fine cotton duck that is applied to the wall with a paste and forms a firm, level base upon which to paint. It provides a more substantial body than plaster, and cracks or loose plaster will not show through the final painting coats.

Canvas is made in a very smooth texture, and also in rough textures to give stippled effects. The ceilings and wall panels shown in Fig. 32 are covered with canvas and painted. An oil painting is shown in the panel over the mantel.

168. Sanitas.—Sanitas is an oilcloth type of fabric, applied in the same manner and for the same purposes as canvas. It is made plain and in patterned form, reproducing wall paper and other designs and textures.

Sanitas is a very sanitary material, will withstand hard usage, and can be washed and cleaned without damage to the surface. This makes it especially useful in kitchens, bath rooms and wash rooms, lavatories, playrooms, etc. It is coming into use in living rooms in its unfinished form, as a base for painting, and in its finished designs.

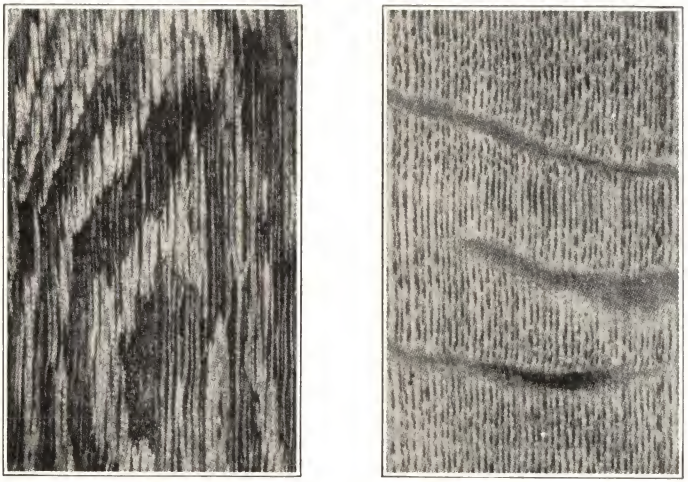
WOOD WALL COVERINGS

KINDS OF WOOD AND THEIR APPLICATION

169. General.—Wood is one of the most common of natural building materials and has been used since early times as a protective and finishing covering for walls and floors. It may be employed in its simplest form in the shape of boards of different widths, vertically on walls and horizontally on floors. It may be used in very elaborate designs using panels, moldings and carved ornament, as shown in Fig. 37.

170. Woods Customarily Used.—When the wood is to be painted or enameled, white pine, poplar, and basswood are used. Some of the soft woods such as knotty pine or pecky cypress have special characteristics and lend themselves to interesting effects. A ceiling finished in pecky cypress is shown in Fig. 5.

Hardwoods have pleasing grain and markings, which can be emphasized and modified by the use of transparent stains. Oak, mahogany, birch, gum, and yellow pine are among the woods that lend themselves successfully to staining.



(*a*) (*b*)

FIG. 38

Each kind of wood has its distinctive formation. Some woods, such as oak and yellow pine, when cut in different directions, show totally different markings. When wood is cut parallel with the grain, it is known as plain sawed, or *flat grain*. When cut across the grain, exposing the edges of the annual rings, it is known as quarter-sawed, or *edge grain*. The plain-sawed or flat-grain effect in oak is shown in Fig. 38 (*a*). In (*b*) is a representation of quarter-sawed oak. The quarter-sawed wood produces a surface more resistant to wear, as well as more beautiful in appearance, than that which is plain-sawed.

171. Shrinkage Precautions.—All wood shrinks in varying degrees, dependent on the direction of the grain and the density of the wood. Care must, therefore, be taken in assembling the pieces to allow for such shrinkage.

172. Erecting Woodwork.—Wood wainscoting is generally applied after the wall construction is finished and all plaster-

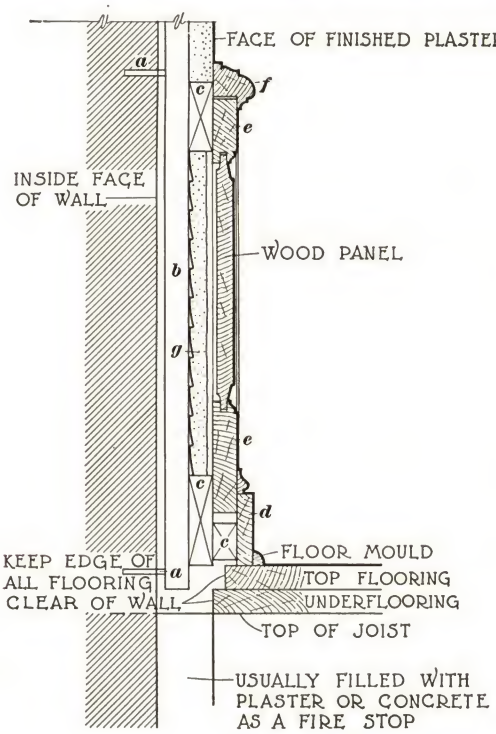


FIG. 39

ing has been completed. Preparation for receiving the woodwork must, however, be made during the construction of the wall.

Nailing strips *a*, Fig. 39, which consist of wood lath, are built into the masonry joints as the wall goes up, and vertical furring strips *b* are nailed to the lath to receive the covering. The furring strips are usually 1″×2″ or 2″×3″ rough lum-

ber, securely nailed to the strips in the wall. The furring strips are placed at proper distances to receive the plastering lath, if plaster is to be used, or to receive the wood wainscoting.

If the wall is to be first plastered, grounds *c*, consisting of wood strips of the widths required, are first fastened to the furring strips at the proper places to receive the base *d*, rails *e*, and cap *f*, which are nailed to them.

When plastering *g* is to be used behind the wainscoting, as is done in the best practice, the white coat is usually omitted and the face of the brown coat is kept back of the face of the grounds so that there will be no direct contact between the plaster and the wood.

173. Millwork.—Finished woodwork that is cut into the proper sizes and molds at the mill, and then sent to the building for fitting and erection is called millwork, and the erection is called carpentry. This is the usual method of constructing wood wall coverings.

174. Cabinet Work.—When the woodwork is cut, fitted, and partly assembled at the mill before delivery, it is called cabinet work. The advantage in this method is that more precise fitting is possible by the use of mill facilities. In this method, door trim, complete panels with stiles and rails attached, and sometimes even the entire sides of rooms are completely assembled, and are erected in large sections at the building.

WOOD FINISHING

175. General.—In a few cases wood is used in its natural state without applying a special finish to the surface. It is, of course, molded, planed, and carved. In the majority of cases the surface is stained, varnished, painted or enameled, by one of numerous methods that have proved satisfactory. These applications to the surfaces are known as finishes, and the general process is called wood finishing.

176. Sandpapering.—Before any finish is applied, the surface of the wood must be thoroughly cleaned of all dirt

and then sandpapered to remove all saw, plane, or hammer marks. Sometimes the wood is first wet to raise the loose grain so that the wood can be sandpapered to a smoother face. As each coat is applied, finer-grained sandpaper is used, and it must be used more carefully in order to avoid cutting through the coats already applied. No matter which method of finishing is used, sandpapering is as important as the application of the paint or stain, which should be applied only over a fine smooth surface. The smoother the surface the better the paint will adhere, and the less brushing will be required to give a satisfactory surface.

177. Priming Coat in Painted Finish.—The first coat of paint in painted work is called the priming coat. Where possible, this coat should be applied at the mill, in order to protect the surface of the wood. The wood will be further protected if the back of the woodwork is given a coat of pure white lead or aluminum in linseed oil. This coating is known as *back painting.*

178. Second Coat.—Paint is applied in two or more coats, depending on the kind of wood used and the type of finish desired. Three coats, including the priming coat, are generally recommended. The wood must be thoroughly dry and smooth before any paint is applied. If the final coat is to have color, it is usual to color the priming coat with the same color as the final coat in order to form a tinted base. If there are any knots in the wood to be painted, they should be covered with shellac before being primed, as paint does not adhere naturally to a knotty surface.

The second coat usually contains enough oil to form a good body. This gives a firm, hard base to receive the final coat or coats. When more than three coats are used, the coats can be thinner and brushed out more, giving a finer finish.

179. Final Coat.—In painted work, the final coat is usually mixed with an enamel, which gives a glossy protective surface capable of being cleaned, although where light reflection must be killed, a flat final coat is used. Pure enamel,

when used without mixing, gives a high gloss with a brilliant surface. It is generally used where much cleaning is required and where grease is present, as in kitchens, laboratories, etc. A dull or egg-shell enamel finish is generally preferred and may be secured by rubbing the last coat of enamel with ground pumice stone and water, after it has thoroughly dried. This cuts the high gloss and produces a pleasant, velvety finish. Today, prepared paints are produced in which the base is enamel and the finished effect is a dull gloss.

180. Flat Finish.—Flat finish can be obtained by the use of white lead, tinted to the color desired, without using any enamel, or it can be secured in enameled work by what is known as stippling. This consists of tapping the last coat of paint with a large brush, about 4 in. × 10 in. in size, with fine or coarse bristles, depending on the effect desired. This gives a slightly irregular surface from which all sheen has been eliminated, giving all of the advantages of the protective coating of enamel without its gloss.

181. Overstaining Painted Woodwork.—Antique effects on painted woodwork are obtained by overstaining. A very thin coat of clear varnish or oil stain, tinted to the depth desired, is brushed thinly on the woodwork, and then wiped off the high surfaces with a rag. The stain can be removed until the desired effect is obtained.

When the stain is applied over moldings and is wiped off only on those portions with the greatest projection, leaving the stain color in the recesses in the molds, the process is known as high-lighting. It causes shadows on the moldings to be accentuated, as though the woodwork had aged gradually.

182. Stained Finish.—In stained finish, advantage is taken of the effects produced by the natural grain of the wood, and the kind of stain varies with the kind of wood on which it is to be applied. The first, or staining coat may be either an oil, an acid, or a water base stain, according to the finish to be secured. It should be as near as possible to the final color,

in order to avoid the use of coloring pigments in the final coats, which would have a tendency to make the finish muddy.

After the stain has dried, a coat of transparent filler is applied to fill up any minute holes that exist in the surface of the wood. The stain and filler are often put on at the same time. This results in a flat even surface of the desired color.

183. Waxing Stained Finish.—The protective coats over the filler may be entirely of wax, or there may be first applied a coat of varnish or shellac over which the wax is applied. If a varnish finish is desired, the varnish is applied in at least two coats. Where wax is used, each coat should be carefully rubbed with a soft cloth before the next is applied. This gives a soft, smooth surface with a slight sheen.

STONES AND MARBLES

184. Types.—Stone wall coverings are formed of natural stones, such as marble, granite, slate, and soapstone. The characteristics of the various kinds, their methods of production, finishes, etc., are described under Floor Coverings.

185. Setting Stone.—Certain types of stone, such as granite and limestone, when over 4 inches thick, can be used as self-supporting walls. When less than 4 inches thick, wall coverings of these stones are usually attached to structural walls by means of galvanized-iron wall ties, spaced to enter into the joints of the covering stones, and bent down to hold them in position. Grooves are cut in the top edges of the stone slabs to receive the turned-down portions of the ties. Marbles, travertines, slates, and sandstones $\frac{7}{8}$ inch thick are secured to walls in this way. The slabs are set before the ties are placed, generally by what is known as the spotting method. Spots of mortar, either of plaster of Paris or stainless cement, are put on the wall around the edges of the slabs, and the slabs are then set and pressed into position. With the placing of the ties they are held in position until the mortar has set, and are then held firmly in place.

186. Finishes.—In the selection of the finishes used on stones to be used as wall coverings, full advantage should

be taken of the color, veining, and natural texture of the stones. Honed and sand-rubbed finishes are acceptable where quiet effects are desired.

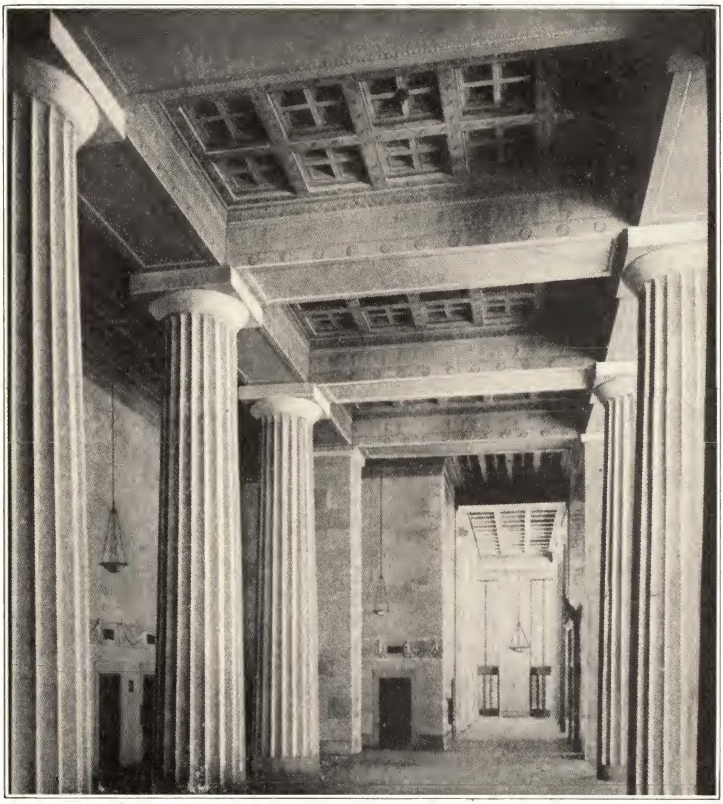


FIG. 40

Where granites, marbles, travertines, and some kinds of soapstone are used, a polished finish is the most desirable, as it brings out the color and the irregular veinings and formations. Honed finishes and sand-rubbed finishes are also sometimes used.

For slate, sandstone, limestone, and the general run of soapstones, the honed finish is the finest and most used in wall

FIG. 41

work. Flagstones and similar stones are usually given a fine sand-rubbed finish.

Some of the softer stones, or those too brittle for use in floors, such as the highly-colored marbles and onyxes, with strong vein formation, make especially good wainscoting.

187. Uses.—Stones are extremely practicable as wall coverings. Their especial usefulness is adding dignity to rooms of monumental character, such as in Figs. 40 and 41. They require little attention after installation and the finishes last for many years. Accumulations of dirt can be readily removed without damage to the finish or color of the stone.

Of all the stones used for wainscoting, marble is the most popular, perhaps because of the wide range of choice in color and veining. When the slabs are placed next to each other and the veins are matched so that they form a continuity of design, it enhances the architectural treatment of any surface on which it is used. In lobbies and stair halls, especially, marble serves both as a decorative and a practical material.

TILE WALL COVERINGS

188. General.—Clay tile, their methods of production, sizes, grades, and classes, have been fully described under Floor Coverings. Most of the many types of tile already mentioned may be used for wall coverings, but certain types, such as quarry tile, pavers, and the unglazed ceramic mosaics, are confined almost entirely to use on floors. Glazed wall tile, which is made on a non-vitreous body, is used almost exclusively for walls.

189. Sizes and Shapes.—The standard sizes and shapes of tile shown in Table II are used for wall work also. There are, however, other sizes and shapes available. Especially is this true of the hand-made types, such as the faience, where sizes and shapes can be produced to suit any design, including designs on the individual tiles as shown in the mantel in Fig. 13.

190. Trimmers.—The use of trimmers is much more usual in wall than in floor work. They are tiles of special forms

FIG. 42

FIG. 43

that are used as the bases and caps of wainscoting, as trim around openings, for panel treatment, and for similar features. For buildings such as hospitals, sanitary coves and plain trim with rounded corners are extremely practical and can be easily cleaned.

191. Wall Treatments.—For the unusual architectural wall treatment and service, selection is usually made from some of the faience or hand-made unglazed tiles. With these, many

FIG. 44

colors and effects are possible owing to their hand-patted irregular faces and edges and their shading in tone. They may be laid in patterns with wide joints, and the joints filled after the tiles are set, or they may be set with close joints with the joints grouted, giving a mosaic effect, as in the fountain recess in Fig. 42.

192. Faience Tile.—Faience tiles are the glazed, hand-made kinds, having irregular surfaces and textures as indicated in Fig. 43. The wall, and also the mantel, consisting of twisted columns and a shelf, are made of glazed faience tiles, and the floor is of unglazed hand-made tiles.

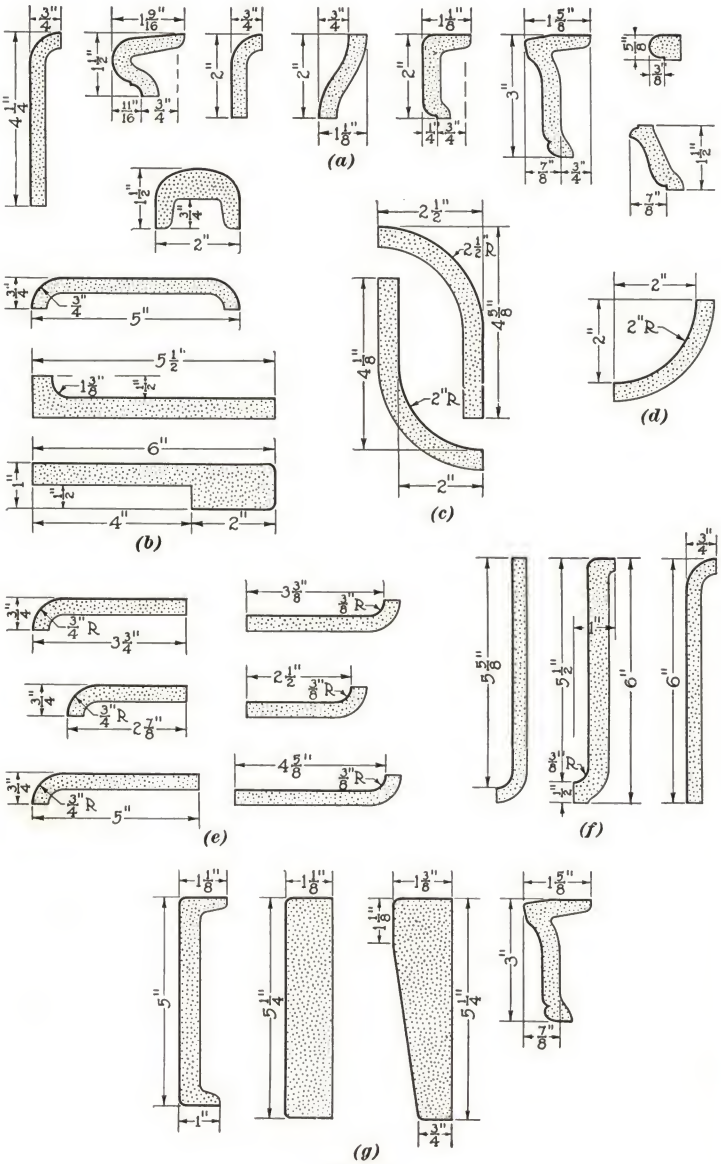


FIG. 45

193. Glazed Tiles.—Glazed tiles having enameled surfaces on non-vitreous bodies comprise by far the largest production of tiles for wall use. The edges of this type being fairly smooth, they can be laid with either a close or a wide joint. The color range is very extensive, including shades of almost every color, and mottled, stippled, or crackled effects.

The less expensive tiles of this type are much used in bathrooms, kitchens, and lavatories, in low- and moderate-priced homes. The better types are used in such places as school corridors, as shown in Fig. 44, cafeterias, laboratories, hospitals, and places where sanitary protection is necessary.

194. Combinations.—The different types of tile afford great freedom of design. They can be used in the same room in interesting combinations, in which advantage can be taken of the colors and sizes to develop the effects. The use of design tile in bands or as accents, as shown in several of the illustrations, adds also to the effects. Some excellent ways in which the different types can be combined are:

Floor and base of quarry tile; wainscot and cap of glazed wall tile.

Floor border of glazed faience; field hand-made unglazed; wall glazed faience, molded cap, and opening trim.

Base and cap of wall glazed faience; wainscot of glazed ceramic mosaic.

195. Trimmers.—In addition to flat surfaced tile there are available special forms such as bull noses, molded trim and caps, cover bases, and rounded corner tile, all of which are generally known as trimmers. In Fig. 45 are shown some of the variations which can be obtained. The heavy lines show the exposed surface of the tile.

In (*a*) are cap returns and moldings used as finish at the top of wainscots; in (*b*) are miscellaneous trimmers used at special places for finishes; in (*c*) are subway combinations used where large sanitary bases and coves are needed; in (*d*) is a cove used at floors and inside corners; in (*e*) are small radius combinations used at external corners; in (*f*) are tiles used for bases; and in (*g*) are architrave and plinths used

at openings for finish. Of these the cove mold is usually used for the joining of floor and wall, although trimmers are generally used in wall work, as later described.

196. Uses.—Tile is especially adapted, from the practical point of view, for use in such rooms as kitchens, bathrooms, lavatories, wash rooms, locker rooms, corridors, and spaces where cleanliness is important, and where there is a possibility of water being splashed on walls and floors. When a kind of tile is selected that is to be laid with a close joint, it will be found that it also gives the floor a decided non-slip quality.

As a purely ornamental or decorative material, tile can be used in almost every kind of room, from the simplest and most informal den or vestibule to the most elaborate monumental room, living room, museum, or library. A very unusual tile installation is shown in Fig. 13. In addition to forming the entire floor, tile is also much used as a border only, in conjunction with marble, or vice versa, as shown in Fig. 4.

197. Installation of Wall Tile.—A scratch coat of mortar made of 1 part cement to $2\frac{1}{2}$ or 3 parts sand, is applied to the wall no matter whether the construction is of wood or of masonry.

Where the tile is to be applied over wood construction, metal lath is securely fastened to furring strips. The scratch coat is well troweled on the lath and leveled off at the proper distance behind the face of the finished tile. While wet, it is well scratched with a trowel in order to give a key for the next coat. It must not be less than $\frac{1}{4}$ inch thick and should be applied not less than 24, nor more than 48, hours before the setting bed is applied.

When the scratch coat is placed directly on masonry, the vertical face of the masonry should be reasonably true and sufficiently rough to form a good key to hold the mortar. Over such materials as gypsum block, cork, or other forms of insulating material, a layer of waterproof paper must first be attached and the metal lath used as over furring, as the

cement mortar used for the scratch coat will not adhere to these insulating materials.

198. Plumb Coat.—In cases where the wall is too much out of plumb to be brought to a true surface with the scratch coat, a second coat, of the same composition as the scratch coat, is applied. This is called the plumb coat. It should not be over $\frac{1}{4}$ inch thick, in order to adhere properly and to set, and should be scratched on the surface.

199. Methods of Setting Tile.—After the scratch or plumb coat is ready the tile is applied. There are two methods used in setting tile: the floating and the buttering method.

Buttering Method.—In the buttering method, dabs of mortar, called screeds, are placed on the scratch coat and flattened to the level of the face of the tile. These give the levels to which the finished surfaces of the tile are set, and they are removed as the wall is finished. The tile is then placed where the screeds were used. After the scratch coat is thoroughly moistened, it is ready to receive the tile.

A very thin coat of mortar, called the setting mortar, is spread, or buttered, on the back of each tile. The tiles are then placed on the wall and pressed and tamped into place to a level with the top of the mortar screed. When dry they are ready for pointing.

Floating Method.—In the floating method, also, the scratch coat is thoroughly moistened. The setting mortar is spread evenly thereon, being brought to the level of the back of the tile. Then a very thin skim coat is spread either over the setting mortar or on the back of the tiles. The tiles are then placed on the wall and pressed or tamped into position.

200. Wetting Tile.—In all cases the tile, except the types having vitreous, non-absorbent bodies, must be thoroughly soaked in water before they are set. This prevents the tile from absorbing water from the wet mortar and thus spoiling the adhesion by drying the mortar too fast.

201. Mortars.—The setting mortar used in both methods consists of from $\frac{1}{2}$ to 1 part lime putty, 1 part of portland

cement, and from 3 to 4 parts of sand. The skim coat is neat portland cement mixed with water. In all cases the tile must be set before the setting mortar has undergone its initial set. Hollows in the back of the tile, particularly in the trimmers, must be completely filled with mortar before setting.

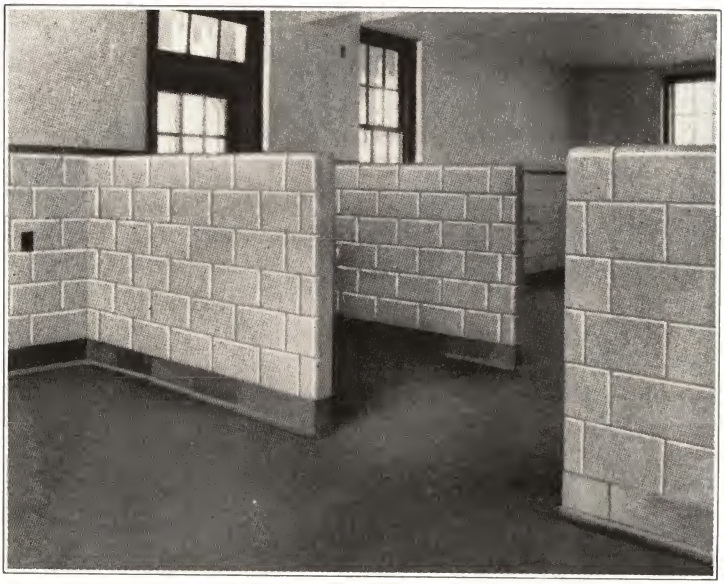


FIG. 46

202. **Filling Joints.**—After the setting mortar bed has hardened sufficiently to hold the tile firmly in place, the tile should be thoroughly washed with water and the joints filled. This is done by grouting with a cement and sand mortar in the case of close joints, and pointing with a stiffer mixture in the case of wide joints. Under the subject Floor Coverings are given the widths of joints recommended for the various types of tile, which apply also to wall work.

After the joints are filled, the wall is again washed and left clean. Unglazed tiles are sometimes given a thin coat of linseed oil, applied with a rag and wiped off, as this brings out the color.

Whether the close or the wide joints should be used depends in great measure on the need for wall protection. In kitchens wash rooms, etc., the joints should be close, so that the walls can be easily cleaned, while, where design is first consideration, advantage can be taken of the interesting effects by the use of the contrasting color in the wider joint.

TERRA COTTA

203. Composition.—Terra cotta is formed of fine clays, pulverized and screened, to which mineral pigments may be added to obtain different color effects. These mixtures are wet, formed into blocks, and burned in a kiln at high temperatures.

204. Sizes.—When produced for wall covering the blocks of terra cotta are standardized as to size. The units come in sizes, $5'' \times 12''$, $6'' \times 12''$, $8'' \times 16''$, and $9'' \times 14''$, the thicknesses being $1\frac{1}{4}$ to $1\frac{3}{4}$ inches. Blocks of greater thicknesses are available where required and these blocks, or units, are made with both sides finished for use in separating partitions as shown in Fig. 46.

205. Classes.—For use as wall coverings, terra cotta wall units are of three general kinds: the unglazed wall units, salt-glazed wall units, and architectural terra cotta wall units. The differences are in the methods of finishing and in the cost of the material.

206. Unglazed Wall Units.—The simplest kind of terra cotta is the unglazed wall unit, which consists of the natural clay body, without the addition of any mineral colors or glazes, burned to vitrification. The surface is hard and nonporous, but is slightly rough. The edges are not ground, and there is a slight unevenness in surface when the tile is laid in the wall. The color is the result of the clays used, and is generally of a light buff shade. Joints are made about $\frac{1}{4}$ inch wide in order to take up the uneven edges.

207. Salt-Glazed Wall Units.—Salt-glazed wall units are of the same composition and quality as the unglazed wall

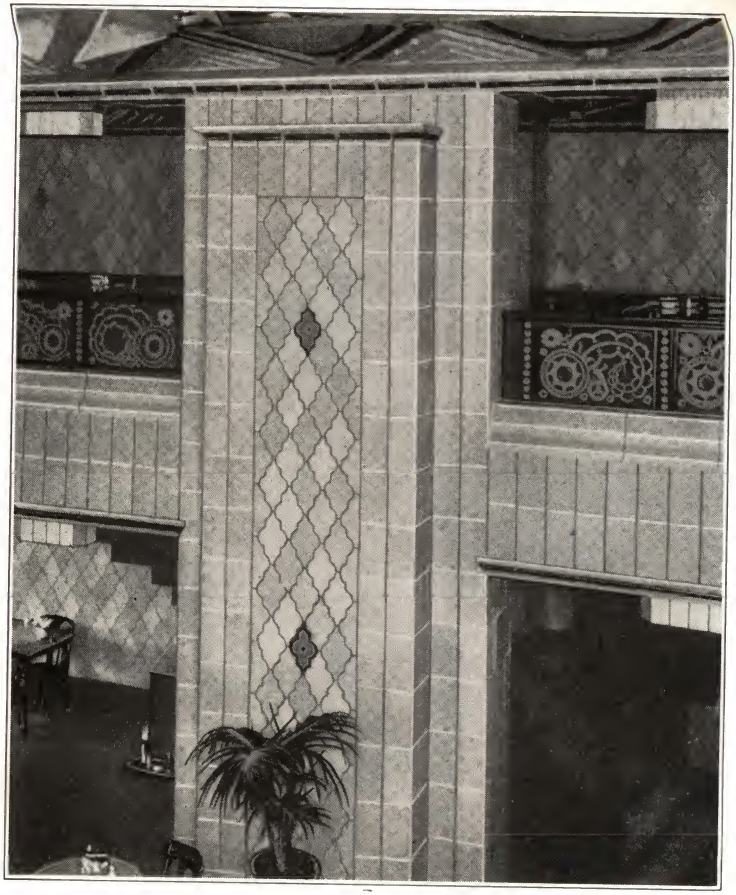


FIG. 47

units, the difference being that salt is sprinkled on the surface before they are burned. This produces a hard, impervious glaze, and a somewhat darker color than that of the unglazed units. The color ranges from light to deep buff. The edges are reasonably straight and, if they are not ground, some variation in laying will occur. These units resist very hard wear and all but the strongest acids. Having a smooth surface they are easily kept clean and in a sanitary condition.

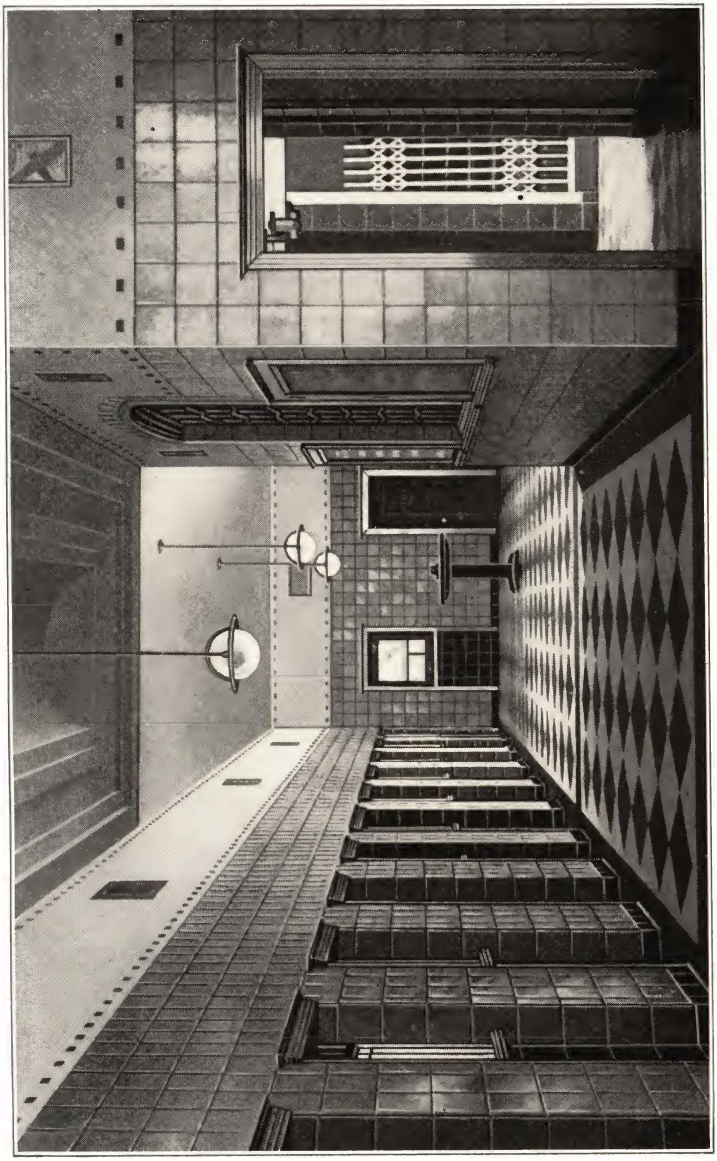


FIG. 48

208. Architectural Terra Cotta.—Architectural terra cotta is also called wall ashlar or terra cotta wall units. The clays of which they are made are ground finer, and mineral pigments are added to obtain color effects. After firing, the blocks are ground to a straight edge, hence they may be laid with a joint as narrow as $\frac{1}{8}$ inch.

Architectural terra cotta units can be produced in various color and surface effects, including polychrome effects. One unusual feature of this material is in the use of metals such as gold, silver, copper, and aluminum, which are applied on the surface and then fused in, giving a metallic appearance to the surface. Both bright and dull glazes are produced and the surfaces can be plain, mottled, stippled, or have designs impressed upon them in one or more colors. While produced in the standard sizes, this kind of terra cotta is used also for architectural design effects, such as shown in Fig. 47.

209. Uses.—All of these kinds of terra cotta make excellent wall coverings for such locations as gymnasiums, school corridors, industrial establishments, and lobbies, where it is desired to have a clean wall surface with resistance to hard usage. The architectural terra cotta, in addition, has all the flexibility required to carry out architectural design treatments, as in the illustration in Fig. 48. In this illustration, terra cotta units cover the lower portions of the wall, including the jambs of the door openings. The floor is of terrazzo, and the walls above the terra cotta are of plaster.

210. Shapes of Units.—Terra cotta units are available in various shapes, such as coves, caps, bull noses, and molded trim. In the case of the architectural terra cotta these shapes are usually made up to suit the design. Difficult and intricate shapes, reproduction of sculptural models, surface variations to form panels, and columns and pilasters are made up and burned without difficulty.

211. Setting Terra Cotta.—The setting of the terra cotta units is in general similar to the setting of brickwork. Port-

land cement mortar is used. With it the backs of the blocks are well buttered before setting, and all voids and hollow spaces are filled.

When the thin units are laid as a wainscoting, wall ties of galvanized iron should be built into the structural wall not more than 18 inches apart. In blocks that are 4 inches or more in thickness, which are self supporting, these ties are unnecessary. Experience has shown, however, that if some ties are used with these thicker blocks, better construction will result.

212. Mortar for Setting.—The setting mortar used with terra cotta units should be composed of 1 part portland cement to from $2\frac{1}{2}$ to 3 parts of sand. When the thin units are used, a setting coat of mortar is first applied on the masonry wall, and the units are buttered on the back before placing. This assures good construction and adhesion. The joints should be well filled as the units are laid and then struck smooth on the surface. When stainless white cement or colored joints are desired, or when mastic-filled joints are used for acid protection, the mortar is kept about 1 inch back from the face, and the joint is filled after the wall is completed.

ARTIFICIAL STONES

213. Description.—The use of white portland cement in combination with various aggregates and colors has brought about the development of many synthetic stonelike materials that resemble natural stones. These artificial stones are made by being cast in molds, the surfaces troweled to the texture desired, and the blocks allowed to cure. Some are so similar in color and texture to the stones for which they are substitutes that it is difficult to distinguish them from the natural stones.

214. Advantages.—Artificial stones have some advantages over natural stones. If properly made they have the same physical properties, including resistance to wear. They can be made in almost any reasonable size and thickness, and can be adjusted to suit irregular conditions at the building.

FIG. 49

In Fig. 49 is shown a wall made of artificial stone against which is placed an antique marble mantel. A handsome wood ceiling is also shown.

215. **Cast Stones.**—Artificial stone is usually cast in blocks in imitation of limestone and granite. The blocks have the same surface finishes and textures as are described for the

natural stones, except the polished finish on granite. Molded details can be formed in cast stone without difficulty. The blocks can also be carved as are the natural stones.

Cast stones are also produced without any attempt to imitate other materials. In these castings, advantage is taken of the possibilities of color mixes of cement, sand, and other ingredients, and effects have been produced which have high decorative values. The surfaces of this stone are generally of a fine sand finish, but a stippled or sanded effect can also be obtained, as well as stucco and rough cast textures. Color effects are produced by adding different materials, such as ground glass, ceramics, stones, and minerals, each of which creates its own effect.

216. Setting Artificial Stones.—Cast artificial stones, when used for wainscoting, are generally set in the same manner as stone masonry. The thicker types are set as self-supporting walls, while the thinner types are set in the same manner as marble slabs. All require rigid foundations or bases and every precaution should be taken against shrinkage or settling.

TERRAZZO

217. Terrazzo as a wall covering is usually cast in molds and finished as described under Floor Coverings. It is generally placed over metal lath, upon which a scratch coat has been placed before the cast terrazzo is applied. The finish of the terrazzo is a fine quality honed, semi-polished surface. The same color variations are possible as in floor work, colorful marbles forming the basis for selection.

GLAZED BRICK

218. Glazed Brick.—A specific type of brick that is especially produced as interior wall lining is that known as glazed brick, which is a clay brick formed of a hard body and given a coat of glaze, producing an enameled surface. It is used for the same general purposes as glazed wall tile and ceramic

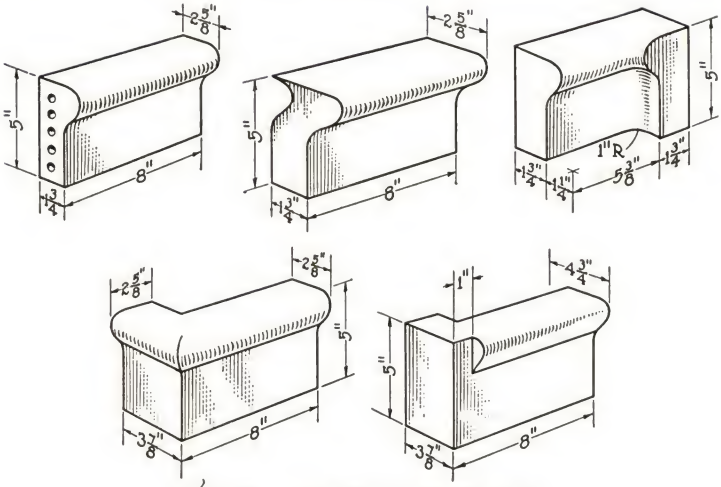


FIG. 50

glazed terra cotta. It has a hard, impervious surface, resistant to grease and dirt, and to practically all acids.

Glazed brick is much used in places where reflection of light is desired, as in dairies, laboratories, gymnasiums, cafeterias, and operating rooms in hospitals.

219. Sizes.—The standard size of glazed brick is the same as that of other types of brick, namely, $2\frac{1}{4}'' \times 3\frac{1}{8}'' \times 8''$. The brick can be enameled not only on the face, but also on the edges and ends, so that a wall can be laid with all the exposed faces enameled. Glazed brick are also available in shapes such as coves, rounded interior and exterior angles, caps, etc., as indicated in Fig. 50.

The method of production, and the sizes, shapes, and colors of glazed brick are all well standardized. Some manufacturers also produce large-sized units, such as $5'' \times 3\frac{1}{8}'' \times 8''$ and $5'' \times 3\frac{3}{4}'' \times 12''$, which are used in spaces where such units, comparable to terra cotta units, are required. Another advantage in these larger sizes is a reduction in the number of joints, which is important where sanitation is desirable.

220. Surfaces and Colors.—There are three general types of surfaces in glazed brick: salt-glazed, ceramic glazes, and enamels. The glazes are available in both high-gloss and matt, or dull, glaze.

The most usual colors are cream, ivory, buff, tan, green, and grey. White and black can also be had. Variations in these colors are made, including mottled and stippled effects.

221. Laying Glazed Bricks.—Glazed bricks are laid in the same manner as other types of clay brick, except that the mortar is kept back from the face of the bricks and they are usually pointed after completion of the laying. For this a non-staining cement mortar is used. In some cases the mortar is colored, especially when a special color of brick is used to form a wainscot pattern. Striking effects can also be obtained by using different colors in the wall, or by using the darker colors as the base and cap, with a field in light tones.

222. Quality.—In selecting glazed brick, the particular quality desired should be stipulated, as glazed brick is available in four standard grades. As these grades vary in several of the types, it is necessary to make special selections in each case.

STRUCTURAL GLASS

223. General.—Glass produced and used for wall covering, either decorative or practical, is commonly known as structural glass. It is made by several manufacturers, each of whom has a particular trade name for his material. Structural glass has a hard, impervious surface, usually in color, and always opaque. Its effects are illustrated in Figs. 51 and 52.

224. Finish.—The surfaces and finish on structural glass are highly polished. It can, however, also be had with sand-finished or honed surfaces, which are secured by grinding the glass. The surface can also be grooved and thus be given a flakelike finish, or a combination of several finishes can be placed on the same slab in order to obtain or secure various effects.

225. Colors.—Cream, white, and black are the most commonly used colors in structural glass. Brilliant color effects can also be obtained, as indicated in Figs. 51 and 52.

226. Thickness.—Structural glass is used as a wall wainscot in which case it is generally in thin slabs $\frac{1}{2}\frac{1}{2}$ inch thick, the thickness depending on the size of the blocks used and the number of joints. When used as self-supporting slabs, as in forming partitions between shower stalls, it is finished on both sides, and is from $\frac{7}{16}$ inch to $1\frac{1}{4}$ inches thick.

227. Setting Structural Glass.—Structural glass is set in the same manner as marble, the mortar being spotted on the wall and the slabs set against it. The base on which the glass is set should, as in marble, be either masonry or metal lath with cement plaster.

The finished pointing is generally done with stainless cement and lime mortar, and the joints are filled after the slabs are set. The joints usually are very fine, being not over $\frac{1}{16}$ inch wide. In order to make them as fine as possible, the edges of the slabs are ground and fitted together before erection.

228. Uses.—Because of its close texture, its non-absorbent surface, and fine straight edges, structural glass forms an

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FIG. 51

Courtesy of the Pittsburgh Plate Glass Co.

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IG. 52 *Courtesy of the Pittsburgh Plate Glass Co.*

extremely sanitary wall covering. It is resistant to stains and greases of all kinds, and to all but the very strongest acids. It can be made in any convenient size, and can be cut to fit the varying spaces to be covered.

Structural glass is used in the covering of walls in such places as kitchens, bathrooms, lavatories, and cafeterias. It is also used in forming division walls between enclosures in toilet rooms, in lining of shower stalls, and wherever sanitary conditions are rather difficult to maintain.

WALL BOARDS

229. Definitions and Uses.—Wall boards are slabs or sheets of material that are used to cover walls and ceilings as substitutes for plastering. They are made of different materials, such as wood between sheets of heavy paper, and gypsum between sheets of felt; of wood fiber, cane fiber, and wood pulp.

An advantage of using wall boards is that a finished wall surface can be obtained by using them instead of lath and plaster, thereby avoiding the delay, moisture, and dirt that are inevitable when the walls are plastered. Wall boards can be used to advantage in finishing up walls and ceilings in attics or other unfinished wall surfaces in homes that are already built. In such places they can be readily applied by the carpenter in a short time.

The surfaces of the wall board may be plain, stippled, or indented with tile or other patterns, and may receive finishes such as paint, calcimine, plastic ornament, or paper.

230. Kinds of Wall Boards.—One group of wall boards is made of wood fibers or wood pulp, pressed or cemented together into sheets about $\frac{3}{16}$ or $\frac{1}{4}$ inch in thickness. This group includes Arborite, Beaver, Insulite, Neponset, and Upson boards. Another group is formed of thin sheets of gypsum between layers of felt and includes Certainteed, Gypsolite, Rockwall, and Sheetrock.

Compo Board is made of thin sheets of wood between two sheets of heavy paper. Celotex is made of sugar cane fibers pressed together in the form of a rigid board. Maftex is a

board made of licorice root fibers pressed together. Maizewood consists of cornstalk fibers that are pressed into boards.

Wall boards known as plywood are made of veneered sheets, by gluing together 3, 5, or 7 sheets or plies of wood veneer, the grain being crossed in the alternate plies. Plywood is $\frac{1}{8}$ inch to $1\frac{3}{4}$ inches thick. The thinner plywood can be bent to form curved surfaces.

231. Sizes of Wall Boards.—Wall boards are generally made 32 inches and 48 inches in width, so as to be nailed to studding placed 12 inches or 16 inches on centers, with very little waste.

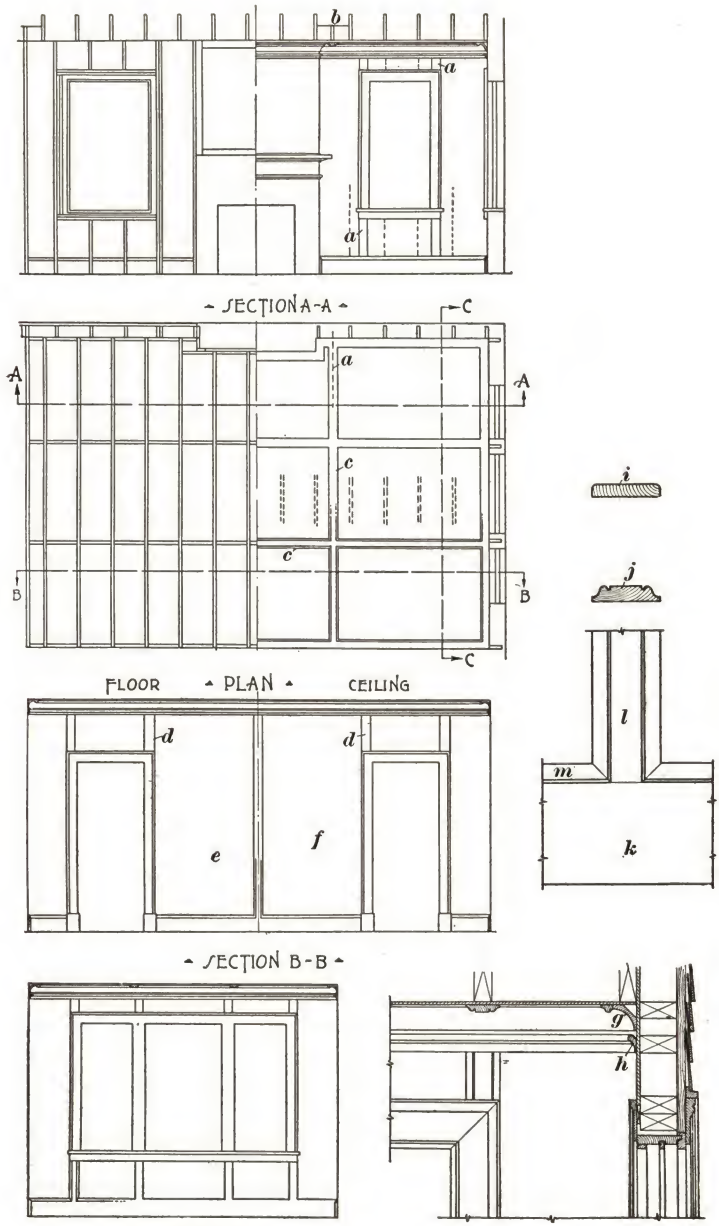
The thickness of boards made from wood fiber is from $\frac{3}{16}$ to $\frac{1}{4}$ inch. Gypsum boards are made $\frac{3}{8}$ inch in thickness. Celotex is about $\frac{7}{16}$ and $\frac{7}{8}$ inch thick, and Compo board is about $\frac{1}{4}$ inch thick. Plywood is from $\frac{1}{8}$ to $1\frac{3}{4}$ inches thick.

The lengths of wall boards are from 4 to 16 feet, so that they can be obtained to fit the height of any ordinary room without cutting.

232. Application.—Wall boards are generally placed vertically on the walls of the room. When covering ceilings with the boards a design should be laid out and the boards placed according to the design. The joints of most wall boards must be covered with strips of wood. The pattern on the ceiling should harmonize with the pattern used on the walls.

The fact that strips must generally be used makes a paneled design necessary. There are great possibilities in design in these panels. The principal concern in laying out the panels is to provide grounds for nailing before the boards can be nailed. When the grounds are in place, it is a comparatively easy job to nail the boards in place and to apply the strips.

When the framework of the building and the partitions are put in place the studs are spaced 16 inches on centers. This spacing may not always lend itself to the paneled treatment desired and additional studs may have to be added to provide satisfactory nailing for the boards. Nailing grounds for horizontal rails in the paneling must be nailed between the studs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SECTION C-C

FIG. 53

where rails occur, and for wainscoting caps, plate rails, cornices, and other horizontal features of the finish of the room.

233. In Fig. 53 is shown a plan of a room and elevations of four sides. The studs are already in place in the outside walls and partitions. The floor joists of the floor above the room have also been placed. The window and door frames are in place. In order to cover the walls of this room with wall boards a design must be made. In making the design, the widths of the wall boards must be considered. The boards should not be cut any more than necessary, as cutting results in waste. Judicious cutting, on the other hand, may be economical if it saves the workmen's time. Small pieces can be used around windows and doors.

The ceiling of this room is 12 feet wide and will take 3 widths of board. Three strips may therefore be used as shown in the right-hand half of the plan. The room is 18 feet long, so that it may be divided into 9 rectangles. One sheet of board $4'0'' \times 12'0''$ will cover 2 rectangles without waste. Blocking, or grounds, as indicated at *a* and *b*, must be put in place before the boards are put on the ceiling. This blocking must provide nailing for the boards and for the strips *c* that are used to cover the joints.

On account of the location of the chimney, doors, and windows, the strips on the walls will have to be cut, as the spaces between these features are not wide enough to take the full widths of the boards. Strips can be placed as shown at *d*. The spaces *e* and *f* will each take a 4-foot board, but to fit in the remaining wall spaces the boards will have to be cut. These spaces are narrow and pieces of board to fill two or three of them can be cut from one width of board. The space above the mantel shelf can be filled by using a board of standard width placed horizontally, if the width and character of the board will permit.

Before the boards are put on the side walls, suitable studs must be placed. A horizontal ground must be placed just above the baseboard to receive the lower ends of all the boards on the side walls. The window and door trim may be placed around

FIG. 54

the doors and windows after the boards are all in place. The cornice *g* and picture mold *h* and the strips *c* and *d* are also placed after the boards are in place.

234. Strips.—The strips may be plain in section as at *i*, Fig. 53, or with molded edges as at *j*. Care should be taken, when joining these strips to the base, chair rail, or cornice, to have the strips miter with these features neatly. Thus the base *k* should have the same mold on the top as the mold on the strip *l*. The moldings *m* on all the strips, bars, cornices, etc., may be made separately if desired, and all put on after the strips, base, etc., are in place.

The application of gypsum wall boards is practically the same as for wall board just described. When joints occur in the face of the wall, the joint may be filled with a special plaster, or by filling and pasting narrow strips of cloth or paper over the joints.

Plywood may be applied exactly the same as wall board. In many cases, however, the plywood is nailed to grounds after the brown coat of plaster has been applied.

An example of a living room finished with wall-board panels with strips at the joints is shown in Fig. 54.

LINOLEUM WALL COVERING

235. General.—The kinds of linoleum used for wall coverings are of the same composition and general character as the thin gages of plain linoleum. The surfaces, however, are finished to provide a texture more suitable for the wall. They are usually made about $\frac{1}{16}$ inch thick.

Wall linoleums can be secured in plain or mottled colors, tile effects, striated colors as in jaspe linoleum, and showing marbleized and wood graining.

The methods of producing linoleum are described in the section on linoleum under Floor Coverings.

236. Uses.—Linoleum may be used as a wall covering where a durable, washable surface is required. An interesting example is shown in Fig. 55, in which the linoleum has been applied to a recreation room. In this illustration the ceiling is

FIG. 55

also finished with linoleum. The floor is covered with asphalt tile. Linoleum is very adaptable to the renovation of rooms in old buildings.

237. Application.—The walls to which linoleum is applied should be of plaster or of a hard, compressed type of wall board, such as gypsum, asbestos, or plaster, in order to hold the paste used in attaching the linoleum.

A water-solvent adhesive is applied to the wall and the linoleum is then hung and rolled with a hand roller until it is perfectly smooth. All irregularities must be rolled out so that there is a continuous contact with the adhesive and the wall, and so that the surface is perfectly smooth.

When rolled smooth, the joints are filled with a waterproof glue and rolled, and all excess material is removed from the wall. The linoleum is then cleaned. Generally no finish is applied, but in some of the effects, like wood veneer, a thin coat of wax can be used, and well rubbed so that the wax will not remain tacky.

ACOUSTICAL MATERIALS

238. Sound Deadening.—A present-day problem in many cases, especially in libraries, hospitals, offices, and similar rooms, is to find a satisfactory wall covering that will absorb sound and will also provide insulation against heat and cold.

For sound deadening, the problem is purely a scientific one. The vibration count, the sound reflection, and the amount of absorption required should be carefully studied by those technically equipped to do so, and the type of material installed should be in accordance with the requirements so established.

239. Acoustical Plaster.—The simplest form of acoustical material is acoustical plaster, which is applied as a final coat on the usual brown coat, or in two coats over a plaster scratch coat. This plaster comes in ready-mixed form, dry, to which is added water, and it is then applied on the wall and floated to a fairly smooth finish. It usually has a wood or an asbestos base, and the finished surface should be porous in order properly to absorb the sound.

240. Acoustical Tile.—Acoustical tiles are made of the materials which have been found to be most effective for sound absorption and noise reduction. They are produced individually for each of these results.

The sound absorption types of acoustical tiles are those used primarily in theatres and auditoriums, where the sound must be prevented from reflecting, so that speaking will not become indistinct to the audience. The other type, for noise reduction, as in industrial establishments, is, as its name implies, primarily for the purpose of reducing the noise vibrations and making the space less noisy. Other requirements are the types used to prevent the passage of sound through the walls.

241. Materials Used in Acoustical Tiles.—The materials mostly used as the base for sound and noise prevention are wood or cane fibre, asbestos, wood pulp, gypsum, magnesite, and cork. They are usually compressed in forms into tile sizes, from 12 to 24 inches square, and have varying surfaces.

Some of the tiles have a fine-grained, close texture, some simulate travertine in surface and color, some have a series of holes on the surface, while others have a very coarse porous surface.

Some of the types come with finished colored surfaces, whereas others are painted after erection. Usually the paint is a special composition, developed for the material on which it is used.

242. Application.—On walls, acoustical tiles can be nailed to wood furring strips, wired to metal channels, or secured direct to masonry walls by setting in mastic. When applied to a wall where there is danger of dampness, the wall should first have a coat of waterproofing mastic. On the ceilings, the tiles are generally suspended, either on wood nailing strips, or by the use of steel-formed angles in which the tiles are individually set.

METAL WALL COVERINGS

243. General.—The use of metal wall coverings for interiors has been greatly increased as the possibilities of aluminum, stainless steel, and porcelain-enameled sheet metal are being

better understood. In most cases these materials are used almost entirely as the result of individual initiative in design. Metals being extremely flexible, subject only to restrictions in size depending on the process of manufacture, there is considerable freedom offered to the designer.

244. Sheet Metal.—Sheet metal has long been used as a base for paint and for purely practical purposes. It is now available in enameled and decorated surfaces of many colors and finishes, and can be used purely for its design value.

Being usually of thin gage, sheet metal can be formed, molded, and fitted around construction supports freely.

The uses of enameled sheet metal are many and varied. Its brilliant colors are especially usable in executing modern designs. Striking effects can be obtained with combinations of colors.

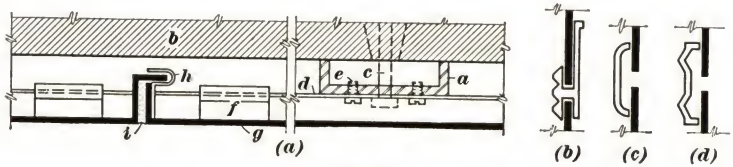

FIG. 56

245. Finish.—The porcelain-enamelel finish in which sheet metal of this type is generally furnished, is composed entirely of minerals which are fused on the rust-proof sheet metal at high temperatures. The result is a hard, brilliant surface which will resist weathering, dirt, and grease, and all but the strongest acids.

246. Types.—Sheet metal is furnished in different materials and types, varying according to the individual manufacturer. The most common type is sheet metal with enameled face secured to the wall supports or to metal or wooden grounds by means of screws. Another method of securing sheet metal is to interlock all joints by the use of aluminum, stainless steel, or a similar non-ferrous metal, in the form of strips which remain exposed and form a part of the finished design. A typical method of installation is shown in Fig. 56.

Channel furring *a* in (*a*) is held to the wall *b* by means of expansion bolts *c*. Bars *d* are held to the channel by means of

self-tapping screws *e*. Clips *f* are attached to the sheet *g* and are bent over the bar *d* to hold the sheets in the required position. Other clips *h* hold the sheets at the vertical joints. These joints usually are filled with mastic *i*.

In Fig. 56 (*b*), (*c*), and (*d*) are shown three forms of extruded aluminum battens. The form shown in (*b*) is made with slots on the sides which hold to the sheets rigidly. The forms shown in (*c*) and (*d*) cover the joint and are held in place by bolts extending through the joint and into the backing. The joint usually is filled with mastic.

In another type the sheet metal is backed with concrete after the color has been applied to the exposed surface. This forms concrete slabs, which are set in the same manner as cast stone. For interior use the slabs are made about 1 inch thick, and they are secured to vertical or horizontal grounds by wires. The joints are then filled with stainless, light-colored mastic, or strips of other materials can be also used to form designs.

There is still another type, which is produced in small sizes like individual tile. They are enameled on the exposed face and edges, which are formed by turning the material back. They are applied on the wall by first nailing thereon a special asphaltum-treated wall board into which grooves have been cut of the proper spacing to receive the metal tile. The tile are pressed into the grooves and the joints are then filled with a mastic compound or by a cement and lime putty mortar, the appearance thus being made very similar to tile, including the joints. This material has a bright glazed surface and can be furnished in almost any color. It is much used in kitchens, bathrooms, corridors, and similar spaces.

247. Aluminum.—Aluminum, when used as a wall covering, is produced in thin sheets by rolling. Ornamental designs are usually pressed or cast, and molds are either formed on dies or extruded by being forced through metal forms.

The thickness of the metal varies to a considerable extent, depending entirely on the nature of the service to which it is to be exposed, as well as the particular method by which it has to be produced satisfactorily to complete the design. Being

free from rust or corrosion, it can be used where it is exposed to dampness.

248. Color of Aluminum.—The natural color of aluminum is a distinctive warm light grey. It can be secured in a fine sand finish, which gives a stippled effect showing the grain of the metal, or the surface can be buffed, giving a satin finish, which is smooth with a semi-polished effect.

Changes in the natural color are secure by applying a deplated finish, which turns the material a dark grey, almost black. This can be slightly lightened by buffing. The finishes in any case vary slightly, depending on whether cast or rolled metal is used, each having a different composition. Usually the finishes on the cast material are slightly darker and coarser than on the rolled metal.

A method has been recently developed by which color can be applied to the surface of aluminum. The colors are confined to red and black, but others are becoming available.

For protection against wear and tear, aluminum is given an anodic bath, which consists in dipping the material in a special solution, thereby producing what is known as *anodized* finish. This finish is less susceptible to wear and prevents darkening or discoloration.

249. Stainless Steel.—Stainless steel is a corrosion-resisting steel, which is used in the execution of architectural designs where its hardness, brilliance of color, and resistance to dampness has made it especially desirable.

Stainless steel comes generally in sheets. It cannot be molded or extruded, and any shapes are formed on a press with dies. It is to a certain extent limited in use for that reason.

Normally, stainless steel is of a steel-grey color, which, when finished, has a semi-polished surface. It can, however, have color applied on the surface as can aluminum, and it can also be secured with a black, sand-finished surface.

In setting stainless steel, special provision must be made to erect substantial supports, usually steel shapes, to which the stainless steel is bolted.

Stainless steel has long been used in commercial establish-

ments for counters, bars, kitchen equipment, and similar places where a metal is required that can be easily cleaned and that has long life. It is now being used also, by taking advantage of its color possibilities, in the creation of wall designs, either by itself or in combination with other metals.